NEXUS PARK

PROJECT MANUAL – VOLUME 2

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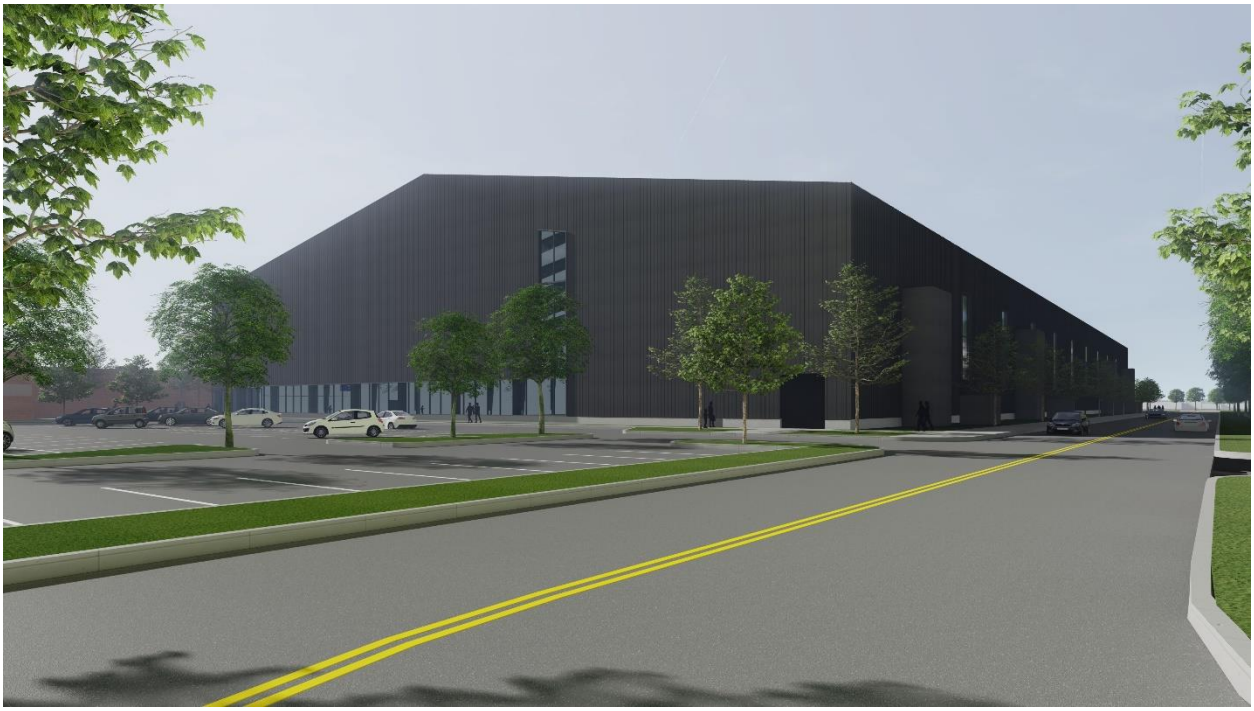

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The following listed documents comprise the Project Manual for NexusPark for scope of work defined under Enabling Phase, Phase 1A & Phase 1B. Where numerical sequence of Sections or Divisions is interrupted, such interruptions are intentional.

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SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements of Division 01 Specifications, General Provisions of the Contract and General and Supplementary Conditions apply to this Division.

1.2 REGULATORY REQUIREMENTS

A. Perform work specified in Division 21, in accordance with the codes and standards listed below of the latest applicable edition adopted by the authority having jurisdiction. Where these Specifications are more stringent, they shall take precedence. In case of conflict, obtain a decision from the Architect.

1. NFPA 13: Standard for the Installation of Sprinkler System
2. NFPA 14: Standard for the Installation of Standpipe and Hose Systems.
3. NFPA 99: Healthcare Facilities Code.
4. NFPA 101: Life Safety Code.
5. ANSI Handicapped Code-A117.1
6. U.L Fire Resistance Index
7. ASTM E814-08B: Standard Test Method for Fire Tests of Penetration Firestop Systems.
8. IBC: International Building Code, with Mechanical and Plumbing Codes.
9. NFPA 10: Standard for Portable Fire Extinguishers
10. NFPA 30: Flammable and Combustible Liquids Code
11. NFPA 54: National Fuel and Gas Code
12. NFPA 70: National Electrical Code
13. NFPA 72: National Fire Alarm and Signaling Code
14. NFPA 75: Standard for the Protection of Information Technology Equipment
15. NFPA 110: Standard for Emergency and Standby Power Systems
16. NFPA 241: Standard for Safeguarding Building Construction, Alteration and Demolition Operations

17. Special regulations, supplement, and amendments of the State and/or local authorities having jurisdiction.

1.3 REFERENCE STANDARDS

A. ANSI: American National Standards Institute.

B. ASME: American Society for Mechanical Engineers.

C. ASTM: American Society for Testing and Materials.

D. AWWA: American Water Works Association.

E. FM: Factory Mutual

F. IRI: Industrial Risk Insurers

G. MSS: Manufacturer's Standardization Society of the Valve and Fitting Industry.

H. NEMA: National Electrical Manufacturers' Association.

I. NFPA: National Fire Protection Association.

J. U.L.: Underwriters' Laboratories, Inc.

K. U. L. Fire Resistance Index.

1.4 SUBMITTALS

A. Submit shop drawings and product data in accordance with requirements of Division 01 including the required number of copies.

B. Include Products as specified in the individual sections of Division 21.

C. Submit shop drawing and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

D. Prepare shop drawings completely independent of the Engineer of Record's CADD files. Should the Contractor or Vendor wish to use the Engineer of Record's CADD files or model as the basis for developing their shop drawings, a release form, obtainable from the Engineer or Architect, must be signed.

E. Submit copies of shop drawings in accordance with Division 01, including:

1. Concrete pads and foundations including anchor bolt and sleeve locations

2. Fire protection systems and hydraulic calculations.

3. Prepare and submit coordination drawings specified herein. Facilitate the coordination effort with other trades, specifically Divisions 22, 23, 26 and 28 and include, but not be limited to the following:

a. Electrical Switchgear Rooms

b. Mechanical Rooms

4. Coordinated room layouts shall include:

a. Room dimensions

b. Locations and dimensions of equipment foundations and pads required.

c. Locations and dimensions of equipment and apparatus, including electrical control panels and starters, and service and coil pull areas.

d. Dimensioned floor drain locations

e. Trench locations and sizes.

f. Sleeve locations in mechanical and equipment rooms.

g. Piping 2" and larger.

h. Conduit 2" and larger.

5. Roof layouts including:

a. Exposed ductwork

b. Exhaust fans

c. Air intakes.

F. Brochures: Submit manufacturer's product data and brochures including:

1. Complete descriptions.

2. Illustrations and wiring diagrams.

3. Rating data, accessories, dimensional data, and applicable options and features marked for the specific items scheduled on drawings and specified herein.

4. Capacities stated in the terms specified and scheduled.

5. Performance curves for fire pumps and jockey pumps.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this Division with a minimum of 5 years of documented experience.

B. Comply with all codes and standards adopted by the authorities having jurisdiction.

C. Perform all required tests of systems, record results and deliver as part of the project closing file.

1.6 FIELD CONDITIONS

A. Layouts indicated on drawings are diagrammatical and intended to show relative positions and arrangement of piping and equipment. Coordinate work with other trades and with measurements obtained at the job site, as applicable, prior to installation. Generally, install work in locations shown on Drawings. Provide necessary rises, drops, and offsets to fit in the available space unless prevented by Project conditions.

B. If prevented by project conditions, prepare drawings showing proposed rearrangement of The Work, including changes to Work specified in other sections. Obtain permission of the Architect before proceeding.

C. Place anchors, sleeves, and supports prior to pouring concrete or installation of masonry work.

D. Cause as little interference or interruption of existing utilities and services as possible. Schedule work which will cause interference or interruption in advance with Owner and all affected trades.

E. Determine sizes and verify locations of existing utilities on or near site.

F. Keep roads clear of materials and debris.

G. Visit site and be informed of conditions under which Work must be performed.

H. Locate equipment requiring periodic servicing so that it is readily accessible. Provide means of service access, following appropriate manufacturer's recommended service clearance space or, as applicable, means of access using wall or ceiling access doors.

I. Install piping to leave sufficient space for AHJ inspection of rated wall construction. Coordinate pipe routing with other trades including but not limited to the work of Divisions 22, 23, 26 and 28.

1.7 FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required to perform Division 21 work.

1.8 COORDINATION DRAWINGS

A. Prior to commencement of installation, prepare coordination drawings for work under this Division, as specified in Division 01. Fully cooperate with persons coordinating and performing work under other Divisions.

B. Drawings shall not be formally submitted but shall be kept on site for reference. Notify the Architect of conflicts that cannot be resolved.

1.9 COMPLETENESS OF WORK

A. The Contract Documents depict fire suppression systems which are intended to be complete and functioning systems. All products, materials, and labor necessary to render a fully functional system to fulfill the design intent shown on the documents shall be provided by the Contractor.

B. Catalog numbers referenced throughout the Division 21 Drawings and Specifications are intended to convey a general understanding of the type and quality of the product required. Where written descriptions differ from information conveyed by a catalog number, the written description shall govern. No extra shall be allowed because a catalog number is found to be incomplete or obsolete.

1.10 PRODUCT SUBSTITUTIONS

A. Comply with provisions of Division 01.

1.11 RECORD DRAWINGS

A. Provide record drawings that illustrate the work of Division 21 as finally constructed. Deliver record drawings to the Architect in a form suitable for reproduction. Comply with the provisions and requirements of Division 01.

B. Record drawings shall reflect all changes made to the Contract Documents, whether generated by addenda, change orders, or field conditions. Maintain a daily record of these changes and keep current set of drawings showing these changes.

C. Deliver record drawings in a form suitable for re-production to the Architect within 30 days of Substantial Completion.

1.12 OWNING AND OPERATING MANUALS

A. Comply with the requirements of Division 01, but provide a minimum of three sets.

B. Manuals shall include clear and comprehensive instructions with appropriate graphics and project specific marked data to enable owner to operate and maintain all systems specified in this Division.

C. Copies of reviewed submittals on furnished equipment shall be included.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPORTS

A. Structural steel for supports: ASTM A36.

1. Use galvanized members installed areas of high humidity or condensation, and outside.

2. Furnish other members with shop coat of red primer.

3. Retouch primer after field welding.

2.2 FLASHINGS AND COUNTERFLASHINGS

A. Furnish materials and coordinate installation for flashing and counterflashing roof penetrations for pipe and drains.

B. Materials:

1. Sheetmetal: 24 gauge minimum ASTM A525, Class G90

2. Sheet lead: 3 pounds per square foot

3. Stainless steel: Minimum 20 gauge

4. Sheet copper: 24 OZ/SF

2.3 WALL AND CEILING ACCESS PANELS

A. Style and type as required for material in which installed.

B. Size: 24"x24" minimum, as indicated, or as required to allow inspection, service and removal of items served.

C. 14 gauge minimum sheet metal for doors, 16 gauge frames of cadmium-plated or galvanized construction. Doors shall have expanded plaster rings where located in plaster walls or flanged finish where located in drywall or block construction.

D. Panels shall have spring hinges with screwdriver locks in non-public areas. Key lock, keyed alike, for panels in public areas.

E. Prime painted or rust inhibitive paint finish.

F. UL labeled when in fire-rated construction, 1-1/2 hour rating.

G. Provide in walls, floors, and ceilings to permit access to all equipment and piping requiring service or adjustment. Examples of such equipment needing access are valves, and equipment needing periodic or replacement maintenance.

H. Furnish and locate access panels under this Division. Coordinate with trades who are responsible for building system in which panels are to be installed.

I. Acceptable manufactures: Milcor, Nystrom, Karp, J.L. Industries, or Williams Brothers.

1. For masonry and drywall construction: Milcor Style M

2. For plastered masonry walls and ceiling: Milcor Style K

3. For ceramic tile or glazed structural tile: Use stainless steel panels

2.4 SLEEVES

A. Materials

1. Concrete floors, concrete and masonry walls: 18-gauge galvanized steel tube with welded longitudinal seam.

2. Drywall partitions: 18 gauge galvanized steel sheet metal.

B. Sleeves shall be sized such that the annular space between outside surface of pipe or pipe insulation and the inside surface of the sleeve is not less than 1/2". Provide larger annular space if required by firestopping product installation instructions.

C. Sleeves supporting riser piping 4" and larger shall have three 6" long reinforcing rods welded radially at 120 degree spacing to the sleeve and shall be installed with the rods embedded in the concrete slab as the floor slabs are poured.

D. Exterior wall and floor penetrations shall be sleeved and sealed with a Link Seal Modular Seal by GPT Industries or Flexicraft Industries.

1. Exterior wall and floor penetrations: Install Link Seal Modular Seal by GPT or Flexicraft Industries. Seal shall be suitable for use in direct ground contact, water or atmospheric conditions with EPDM seal element. Provide Nitrile rubber seal element where subject to oils and fuel. All bolts, nuts and fasteners shall be Steel with 2-part Dichromate corrosion inhibiting coating or Type 316 Stainless steel.

2.5 ESCUTCHEON PLATES

A. Provide B & C No. 10 or equal chrome plated escutcheon plates where pipes penetrate partitions or ceilings in finished spaces or areas.

PART 3 - EXECUTION

3.1 EXCAVATING AND BACKFILLING

A. Contractor shall review Divisions 31 and 33 and shall perform excavation and backfilling in accordance with the most stringent requirements. Contractor shall request clarification before proceeding if there are conflicting instructions.

B. Contract Documents show the approximate location of underground utilities known to exist in the area of construction. Contractor shall determine the exact location of utilities.

1. Locate and uncover existing utilities which require new connections before trenching in the vicinity of indicated utility connection. Contact local authority responsible for locating all existing utilities. Do not perform any excavation until the presence and location of existing utilities has been determined.

2. Clear all vegetation and other objectionable material from the area required for the excavation and backfill operations. Disposal of material removed by the clearing operation shall be approved by the Owner's representative.

C. Provide trenching, excavating, and backfilling necessary for performance of work indicated in Contract Documents.

D. Excavate to depths indicated on the drawings or as necessary to permit the installation of pipe, bedding, backfill, structures or appurtenances. Provide a firm, undisturbed, uniform surface in the bottom of trenches. Where excavation exceeds the required depth, bring the excavation to proper grade through the use of an approved incompressible backfill material. Store excavated material and dispose of surplus excavated material.

1. Excavate trench to sufficient depth to permit a minimum of 36" of cover over the top of the pipe unless otherwise required by pipe elevations indicated on the Drawings. The trench width shall be 18" plus the diameter of the pipe and/or the largest bell.

E. Trenching and excavation shall be unclassified. No extra will be paid in the event that rock is encountered.

1. Should rock excavation be required, use only experienced personnel for blasting.

2. Exercise extreme care when blasting with signals of danger given before firing any charge.

3. Conform to and obey all public authority regulations for the protection of life and property.

F. Provide sheathing, shoring, dewatering, and cleaning necessary to keep trenches and their grades in proper condition and to meet applicable codes.

G. Provide a minimum of 6" of No. 67 crushed stone or clean sand bedding, or equal, in the bottom of the trench to maintain the required grade and continuous support of the bottom quadrant of the pipe.

H. Upon completion of excavation, and prior to the laying of the pipe, the trench bottom shall be brought up to the required elevation with min. 6" pipe bedding. Pipe bedding shall be select material deposited in the trench, and shall be compacted, leveled off, and shaped to obtain a smooth compacted bed along the laying length of the pipe. Material for pipe bedding shall comply with local codes. In absence of local code requirements the bedding shall be bank sand or select back fill material approved by the Architect. Any material used shall pass a 1/4 inch screen.

I. Clean and inspect pipe for defects before lowering into trench for assembly. Install pipe in accordance with provisions of Contract Documents and with the recommendations of the pipe manufacturer.

1. Ensure pipe is of proper strength and classification for specified service. Discard damaged or defective pipe discovered during pipe laying operations.

2. Maintain alignment and grade during layout operation. Use acceptable method for maintaining grade and alignment to produce desired results.

J. Where crushed stone backfill is required, use No. 67 stone, clean sand or equal.

K. After bedding has been shaped and the pipe assembled, place crushed stone carefully around the pipe and to a point 12" above the pipe. Backfill above this point shall be as described below:

1. Backfill areas of vehicular traffic shall consist entirely of crushed stone and compacted crusher run material.

2. Backfill for shoulders of roadways, sidewalk, and slab on grade structures shall consist entirely of crushed stone.

3. Backfill areas not subject to vehicular traffic may consist of suitable excavated material as described above.

L. Where crushed stone is not required, suitable excavated material may be utilized. This includes fine, dry earth or a mixture of earth and shot rock. Rocks larger than 6" in any dimension may not be included in any portion of the backfill material.

M. Trenches shall be backfilled only after piping has been inspected, tested, and approved by the Architect. All backfill material shall be placed in the trench either by hand or by approved mechanical methods. The compaction of backfill material shall be accompanied by tamping, with hand tools or approved pneumatic tampers, by using vibratory compactors, by puddling, or by any combination of the three. The method of compaction shall be approved and all compaction shall be done to the satisfaction of the Architect. Backfill completely around pipe, including 18" above the pipe, with suitable bank sand, tamped in 4" layers under, around, and over pipe. Water down backfill as required. The remainder of the backfill shall be select backfill material tamped at intervals of no more than 12" depths. All materials to be used as selected material backfill shall be approved by the Architect. If, in the opinion of the Architect, the excavated material does not meet the requirements of selected material, the Contractor shall be required to screen the material prior to its use as selected material backfill. Material used in the upper portion of the backfill or subgrade shall not contain stone, rock, or other material larger than six inches in its longest dimension. No wood, vegetable matter, or other material which, in the opinion of the Architect, is unsuitable shall be included in the backfill. The upper 24" of backfill may be water jetted, if desired. Backfill shall be brought up to finish grade identified on the Architectural Drawings, including additional backfill required to offset settlement during consolidation.

3.2 CUTTING AND PATCHING

A. Repair or replace damage caused by cutting or installation of work specified in Division 21.

B. Perform repairs with materials which match existing and install in accordance with the appropriate section of these specifications.

3.3 FLASHING AND COUNTERFLASHING

A. Flash and counterflash pipes where penetration of roofs and outside walls occurs. Coordinate penetration or walls and roof with architectural details and make water and air tight.

3.4 DELIVERY, STORAGE, AND PROTECTION

A. Insofar as possible, deliver items in manufacturer's original unopened packaging. Where deliver in original packaging is not practical, provide cover and shielding for all items with protective materials to keep them from being damaged. Use care in loading, transporting, unloading, and storing to keep items from being damaged.

B. Store items in a clean, dry place, and protect from damage. Equipment may not be staged or stored outdoors unless intended for outdoor use.

C. Protect nameplates on motors, pumps, and similar equipment. Do not paint or insulate over nameplate data.

D. Keep dirt and debris out of pipes.

E. Repair, restore, and replace damaged items.

3.5 SLEEVES

A. Floors: Sleeve all pipe penetrations. Extend sleeve 2" above finished floor, except piping within fire rated pipe chases. Sleeve shall be flush with underside of floor.

B. Masonry or concrete walls: Sleeve all pipe penetrations. Sleeves shall be flush on both sides of wall.

C. Drywall partitions: Sleeve all penetrations of piping through fire or smoke rated partitions.

D. Non-Rated drywall partitions: Sleeves are not required. Seal around penetration with appropriate joint sealing material.

E. Seal voids between outside surface of sleeve and wall, partition or floor. Seals shall be airtight.

F. Install piping and sleeves in strict accordance with applicable U.L. floor or partition assembly instructions. Coordinate with Division 07 Firestop and manufacturer's installation instructions.

G. Penetrations not sleeved or firestopped:

1. Seal voids between pipe and partition. Seals shall be airtight with appropriate joint sealing material.

3.6 ESCUTCHEON PLATES

A. Provide chromium plated escutcheon plates for exposed uninsulated pipes projecting through floors and walls in finished spaces. Mechanical rooms, storage rooms, electrical closets and housekeeping rooms closets are not considered finished spaces.

B. Clearance between sleeve and pipe: Minimum of 1/2" or as otherwise dictated by the UL Fire Resistance Directory.

3.7 CLEANING FIRE SUPPRESSION SYSTEMS

A. General Cleanup:

1. As work proceeds throughout the construction schedule, clean up dirt, debris, old materials, etc., and remove from site, keeping premises in neat and clean condition. See Division 01 of specifications for further requirements.

2. Seepage, discoloration or other damage to parts of the building, its finish, or furnishings due to Contractor's failure to properly clean piping systems shall be repaired without cost to the Owner.

B. Factory Finishes:

1. Clean items with factory finishes. Touch up bare places, scratches and other minor damage to finishes. Use only factory supplied paint of matching color and formula. If finishes are badly damaged or if there are many damaged, scratched or bare places, refinish the entire item.

3.8 TESTING FIRE SUPPRESSION SYSTEMS

A. Test all systems and equipment to demonstrate proper operation to the AHJ, Owner and Architect.

B. Advise the Architect of scheduled systems testing and system demonstration/operation schedules so these tests may be witnessed if desired.

C. Correct and retest work found to be defective when tested.

D. Make all repairs to piping systems with new materials. Peening, doping or caulking of joints or holes will not be acceptable.

E. Test and Balance fire pumps, flow meters and test headers in accordance with applicable standards. Record results and deliver as part of the project closing file.

F. Test, verify and record standpipe system pressures.

G. Test, verify and record all floor control and test valves and all fire alarm connections for proper operation.

H. Test and verify all supervised fire valves for proper function and annunciation at the fire alarm panel. Record and submit proof of testing for Owner's record.

3.9 INFECTION CONTROL REQUIREMENTS

A. Coordinate with the Owner the exact requirements for the infection control measures to be executed and performed during the course of this Project.

B. Prior to execution, present to the Owner for approval a written execution plan for each infection control measure.

C. Coordinate infection control measures as needed with all other trades and disciplines.

D. Provide documentation of infection control measures to the Owner, as required and specified in the ICRA.

END OF SECTION

SECTION 21 05 20
FIRE EXTINGUISHERS, FIRE VALVES AND CABINETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Materials and labor required to completely execute the fire protection work for this project, as indicated on the drawings and as specified herein, including but not limited to:

1. Fire Protection components
2. Fire Extinguishers
3. Valves and Cabinets
4. Fire Department Connections

1.2 RELATED REQUIREMENTS

A. Section 07 84 13 - Penetration Fire Stopping

B. Section 09 90 00 - Painting and Coating

C. Section 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

D. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment

E. Section 21 13 13 - Fire Suppression Sprinkler Systems

F. Division 26: Electrical

1.3 REFERENCE STANDARDS

A. Refer to Section 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION for referenced standards and codes.

B. Verify with the AHJ for the latest adopted editions.

1.4 INSTALLER QUALIFICATIONS

A. Comply with local and state licensure requirements for installation of fire protection equipment and systems.

1.5 SUBMITTALS

A. Submit product data and drawings for review in accordance with the requirements of Division 01. Include the following manufacturer's product data with shop drawings:

1. Valves
2. Fire extinguishers and cabinets

3. Fire Department Valve Cabinet

4. Fire Department Connection

B. Submit product data to Owner's Insuring Agency and AHJ for approval.

1.6 QUALITY ASSURANCE

A. Underwriters Laboratories (U.L.) listed and Factory Mutual (F.M.) approved material.

B. Comply with local fire department standards for hose threads, operating nuts and accessories for hydrants and siamese connections.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Potter-Roemer, Croker, Larsen

B. Potter-Roemer figure numbers are used unless noted otherwise.

2.2 EQUIPMENT

A. FP-12 FIRE DEPARTMENT CONNECTION WALL MOUNTED (STORZ CONNECTION)

1. Type: Wall Mounted made of corrosion resistant metal complying with UL 405.

2. Inlets: 5-inch Storz connection, internal threaded. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.

3. Outlet: Back with pipe threads, 4 NPS (100 DN).

a. Location: Angle.

4. Rated Working Pressure: 175 psi (1200 kPa).

5. Finish: Polished brass.

6. Signage: Raised or engraved lettering 1 inch (25.4 mm) minimum indicating system type.

B. FP-12A FIRE DEPARTMENT CONNECTION FREE STANDING (STORZ CONNECTION)

1. Type: Free standing made of corrosion resistant metal complying with UL 405.

2. Inlets: 5-inch storz fittings, internal threaded. by Civil Division. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.

3. Configuration: Horizontal.

4. Outlet: With pipe threads, 4 NPS (100 DN).

5. Rated Working Pressure: 175 psi (1200 kPa).

6. Finish: Polished brass.

7. Sleeve: Brass, 18 inches (460 mm) height.

8. Signage: Raised or engraved lettering 1 inch (25.4 mm) minimum indicating system type.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate installation to avoid interference with other systems.

B. Provide power and interlock wiring under Division 26.

3.2 FIRE EXTINGUISHER AND CABINETS

A. Mount top of extinguisher 48" (ADA) above finished floor or as required for ADA compliance.

B. Identify on cabinet with 1-1/4" high red lettering "Fire Extinguisher".

3.3 FIRE DEPARTMENT VALVES

A. Locate Fire Department Valves at a maximum of 5'-0" above finished floor. Locate valve wheel operator in a position to allow easy operation. Locate Fire Department Valves within recessed wall boxes per manufacturer's recommendation and in full compliance with ADA requirements.

END OF SECTION

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

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Vibration isolation requirements.

B. Seismic control requirements.

1. Includes requirements for seismic qualification of equipment not specified in this section.

C. Vibration-isolated equipment support bases.

D. Vibration isolators.

E. External seismic snubber assemblies.

F. Seismic restraint systems

1.2 RELATED REQUIREMENTS

A. Section 01 45 33 - Code-Required Special Inspections and Procedures.

B. Section 03 30 00 - Cast-in-Place Concrete.

C. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.

D. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment

1.3 DEFINITIONS

A. Fire Suppression Component: Where referenced in this section in regards to seismic controls, applies to any portion of the fire suppression system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., piping).

B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.4 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASCE 19 - Structural Applications of Steel Cables for Buildings 2016.

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

D. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment 2014.

E. FEMA 413 - Installing Seismic Restraints for Electrical Equipment 2004.

F. FEMA 414 - Installing Seismic Restraints for Duct and Pipe 2004.

G. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage 2012.

H. FM 1950 - Seismic Sway Braces for Automatic Sprinkler Systems 2010.

I. ICC (IBC) - International Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. MFMA-4 - Metal Framing Standards Publication 2004.

K. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems 2008.

L. UL 203A - Standard for Sway Brace Devices for Sprinkler System Piping Current Edition, Including All Revisions.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.

2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Seismic Controls:

a. Coordinate the arrangement of seismic restraints with piping, conduit, equipment, and other potential conflicts installed under other sections or by others.

b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.6 SUBMITTALS

A. Submit product data and drawings for review in accordance with the requirements of Division 01.

B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.

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

1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.

2. Seismic Controls: Include seismic load capacities.

1.7 QUALITY ASSURANCE

A. Comply with applicable building code.

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

C. Seismic Controls Designer Qualifications: Registered professional engineer licensed in State in Which the Project Is Located and with minimum five years experience designing seismic restraints for nonstructural components.

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

1.8 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 VIBRATION ISOLATION REQUIREMENTS

A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing fire suppression equipment.

B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:

C. General Requirements:

1. Select vibration isolators to provide required static deflection.

2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.

D. Piping Isolation:

2.2 SEISMIC CONTROL REQUIREMENTS

A. Design and provide fire suppression component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor fire suppression components.

B. Seismic Design Criteria: As indicated on drawings.

C. Seismic Design Criteria: ICC (IBC).

1. Seismic Design Category: "C".

D. Premanufactured Modular Fire Suppression Equipment: Where not otherwise seismically qualified, premanufactured modules 6 feet (1.8 m) high and taller furnished under other sections to be designed in accordance with seismic provisions for nonbuilding structures.

E. Seismic Restraints:

1. Provide seismic restraints for fire suppression components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.

2. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:

a. ASHRAE (HVACA).

b. FEMA 412.

c. FEMA 413.

d. FEMA 414.

e. FEMA E-74.

f. SMACNA (SRM).

3. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.

4. External Seismic Snubber Assemblies:

a. Provide quantity and arrangement of external seismic snubber assemblies as required to restrain equipment in all directions (both lateral and vertical).

b. Do not use external seismic snubber assemblies that restrain equipment only in one or more lateral directions (but not vertical) except where uplift forces are zero or are addressed by other restraints.

5. Seismic Restraint Systems:

a. Arrange restraint elements to avoid obstruction of sprinklers in accordance with NFPA 13.

b. Except where otherwise restricted, use of either cable or rigid restraints is permitted.

c. Use only cable restraints to restrain vibration-isolated fire suppression components.

d. Use only one restraint system type for a given fire suppression component or distributed system (e.g., piping) run; mixing of cable and rigid restraints on a given component/run is not permitted.

e. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain fire suppression component in all lateral directions; consider bracket geometry in anchor load calculations.

f. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported fire suppression component weight.

g. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported fire suppression component weight.

h. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.

i. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.

j. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.

F. Seismic Attachments:

1. Comply with support and attachment requirements of NFPA 13.

2. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.

3. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.

4. Do not use power-actuated fasteners.

5. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps, but not for sway bracing attachments as prohibited by NFPA 13.

6. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.

7. Concrete Housekeeping Pads:

   a. Increase size of pad as required to comply with anchor requirements.

   b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.

G. Seismic Interactions:

1. Include provisions to prevent seismic impact between fire suppression components and other structural or nonstructural components.

2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.

3. Comply with minimum clearance requirements between other equipment, distribution systems, and associated supports and fire protection sprinkler system drops and sprigs.

H. Seismic Relative Displacement Provisions:

1. Use suitable fittings or flexible connections, in accordance with NFPA 13, to accommodate:

   a. Relative displacements at connections between components, including distributed systems (e.g., piping); do not exceed load limits for equipment utility connections.

   b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.

   c. Design displacements at seismic separations.

   d. Anticipated drifts between floors.

2. Provide clearance around fire suppression system piping extending through walls, floors, platforms, and foundations in accordance with NFPA 13.

2.3 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

2.4 EXTERNAL SEISMIC SNUBBER ASSEMBLIES

A. Description: Steel snubbing assemblies designed for external attachment to both equipment and supporting structure that, as part of a complete system, restrain equipment motion in all directions during a seismic event while maintaining vibration isolation during normal operation.

B. Seismic Snubbing Elements:

1. Air Gap: Between 0.125 inches (3 mm) and 0.25 inches (6 mm) unless otherwise indicated.

2. Points of Contact: Cushioned with resilient material, minimum 0.25 inch (6 mm) thick; capable of being visually inspected for damage and replaced.

2.5 SEISMIC RESTRAINT SYSTEMS

A. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.

B. Where required by NFPA 13, provide products listed as complying with UL 203A or FM 1950.

C. Cable Restraints:

1. Comply with ASCE 19.

2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.

3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.

4. Use protective thimbles for cable loops where potential for cable damage exists.

D. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

PART 3 EXECUTION

3.1 INSTALLATION

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

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

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

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

E. Vibration Isolation Systems:

1. Vibration-Isolated Equipment Support Bases:

a. Provide specified minimum clearance beneath base.

2. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.

3. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.

4. Adjust isolators to be free of isolation short circuits during normal operation.

5. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

F. Seismic Controls:

1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris, or other obstructions.

2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.

3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch (3 mm), use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch (3 mm) or less.

4. Equipment with Sheet Metal Housings:

a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.

b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.

c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.

5. Concrete Housekeeping Pads:

a. Size in accordance with seismic design to meet anchor requirements.

b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.

6. Seismic Restraint Systems:

a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.

b. Install restraints within permissible angles in accordance with seismic design.

c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.

d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.

e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect vibration isolation and/or seismic control components for damage and defects.

C. Provide manufacturer representative or authorized technician services to assist with inspection and testing of vibration isolation systems and seismic controls. Submit a detailed copy of manufacturer recommended inspection, testing, and field report procedures.

D. Vibration Isolation Systems:

1. Verify isolator static deflections.

2. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.

E. Seismic Controls:

1. Verify snubbing element air gaps.

F. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION

SECTION 21 13 13
FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Materials and labor required to completely execute the sprinkler and fire protection work for this project, as indicated on the drawings and as herein specified including but not limited to:

1. Hydraulic design of fire sprinkler system.
2. Shop drawings.
3. Interior pipe, fittings and valves.
4. Wet-Pipe Risers and accessories.
5. Hangers, supports and sleeves.
6. Sprinkler heads and extra sprinkler cabinet(s).
7. Standpipes.
8. Flushing and testing of complete fire sprinkler system, including valves, standpipes and test connections.
9. Demonstration of system operation and performance to Authorities Having Jurisdiction and Owner's representatives.

1.2 RELATED REQUIREMENTS

A. Division 01: Seismic Requirements

B. Section 07 84 00 - Firestopping

C. Section 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

D. Section 21 05 20 - Fire Extinguishers, Fire Valves And Cabinets

E. Division 26: Electrical

1.3 REFERENCE STANDARDS

A. NFPA 13: Standard for the Installation of Sprinkler Systems

B. NFPA 14: Standard for the Installation of Standpipe and Hose Systems

C. NFPA 101: Life Safety Code

1.4 INSTALLER QUALIFICATIONS

A. Comply with local and state licensure requirements for installation of fire suppression systems.

1.5 DESIGN REQUIREMENTS

A. Design 100% hydraulically calculated, automatic sprinkler system as applicable in accordance with Owner's insuring agency guidelines, NFPA 13 and 14, and state and local code requirements.

B. Design system to serve entire project unless otherwise indicated on drawings.

C. Design system with sprinkler zones as indicated on drawings. Pipe/mains sizes indicated on drawing shall not be reduced without engineer of record approval.

D. Base design on the following criteria:

1. Light hazard occupancy in all areas except as noted herein or shown on drawings: 0.10 GPM/SF over most remote area of 1500 SF.

2. Ordinary hazard Group 1 for mechanical equipment rooms, storage rooms, and other areas indicated on drawings: 0.15 GPM/SF over most remote area of 2000 SF.

3. Ordinary hazard Group 2 for trash rooms, loading dock, staging areas, event storage rooms, restaurant and retail spaces: 0.20 GPM/SF over most remote area of 2000 SF.

4. Minimum excess pressure of 10 psi including required hose stream allowance and sprinkler requirements.

5. Maximum pipe velocity of 25 feet/second or as limited by insuring agent.

6. Hose stream allowance based on occupancy classification of remote area in addition to sprinkler demand or as required by Owner's insuring agency:

   a. Light hazard - 100 GPM

   b. Ordinary hazard - 250 GPM

7. A minimum of 18 inches clearance between bottom of sprinkler deflector and top of storage shelving.

8. Include a 3/4" ball drip for all types of fire department connections. Route discharge to outside of building.

9. Base design on results of a recent flow test, not more than one month old, to determine the adequacy of the water supply at the project site. Submit flow test location and results with sprinkler system drawings and calculations.

10. Include dry pendant type sprinkler heads located within cooler and freezer boxes with recess seat located within a conditioned space.

11. Use standard coverage sprinkler heads. Extended coverage heads shall not be used.

1.6 SYSTEM DESIGN

A. Contract Documents require a complete 100% hydraulically calculated automatic wet pipe sprinkler system. Drawings specifically include:

1. Standpipes and valves

2. Pipe sizes based on hydraulic calculations

3. Center to center dimensions for head location

4. One calculated area per zone

5. Node identification for the calculated areas

6. Head types

a. Sprinklers shall be referred to on the drawings and shall be specifically identified by the listed manufacturer's style or series designation. Trade names and abbreviations are not permitted.

7. Construction details, including details for pipe hangers, pipe hanger spacing.

B. Hydraulic calculations for the complete sprinkler system are included as part of the Contract Documents.

1. If for economic reasons Contractor desires to resize or significantly reroute sprinkler piping, include cost for Engineer of Record to redesign system, modify hydraulic calculations, and to resubmit Contract Documents for approval by authority having jurisdiction.

1.7 SUBMITTALS

A. Prepare complete detailed working drawings and calculations for the fire protection systems.

B. Submit drawings and calculations to the State and Local Fire Marshal and to the Owner's Insuring Agency for approval.

C. After receiving approval from State, Local Fire Marshal and Owner's Insuring Agent, submit shop drawings and calculations for review prior to start of installation. Submitted shop drawings shall bear State, Local Fire Marshal's and Owner's Insuring Agent approval stamp. Sprinkler installation shall not commence prior to obtaining approval of the listed authorities.

D. Purpose of shop drawing is to convey that contractor understands intent of Contract Documents and to facilitate coordination of sprinkler system with HVAC ductwork, piping and other trades.

E. Upon completion of the fire sprinkler system installation, an on-site inspection shall be conducted by the engineer to verify that the installation is in accordance with the design and NFPA 13 requirements.

F. Upon completion of required corrections, if any, verified by the engineer, written certification by the engineer stating that the fire sprinkler system and the water supply (source shall be indicated) is installed in accordance with NFPA 13 requirements shall be provided. The certification shall state that the sprinkler system design and installation comply with NFPA 13 (year of edition must be given) requirements. Approval of the fire sprinkler system (both design and installation) is mandatory before permission to occupy the area protected by the fire sprinkler system can be given by the state.

G. Submit for review detailed shop drawings and product data for the sprinkler system in accordance with the requirements of Division 01.

H. Include at a minimum the following manufacturer's product data with shop drawings:

1. Sprinkler Heads

2. Interior Valves

3. Interior Pipe and Fittings

4. Hangers and supports

5. Water flow, pressure and supervisory switches

I. Submit shop drawing and submittal data to Owner's Insuring Agency for approval.

1.8 QUALITY ASSURANCE

A. Use only Underwriters Laboratories (U.L.) listed and Factory Mutual (F.M.) approved material.

B. The automatic sprinkler system installer shall provide a permanently attached nameplate located at the controlling riser, indicating the location and the discharge densities over designed areas of discharge including gallons per minute and residual pressure, and hose stream demand supplied by the sprinkler piping.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in the section with a minimum of 5 years of documented experience.

1. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories (UL) or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.9 PROJECT CLOSE-OUT DOCUMENTS

A. Include fire sprinkler as-constructed drawings in project close-out documents.

B. Comply with requirements specified in Division 01.

PART 2 - PRODUCTS

2.1 VALVES

A. Acceptable Manufacturers: Victaulic,Globe, Nibco, Crane, Stockham, Grinnell, Mueller, Watts, Hersey, Febco, Ames. Model numbers used are to establish required level of product quality.

B. Interior valves:

1. Alarm check valve: Victaulic Series 751 with Series 752 retard chamber, divided seat ring, rubber-faced clapper, UL listed and FM approved. Valve internal components shall be replaceable with valve in the installed position.

2. Check valves:

a. All check valves on discharge side of fire pump shall be non-slam type

b. Nibco No. F-908-W, UL Listed and FM approved, cast iron body, bolted bonnet, bronze mounted trim, horizontal swing, rubber seat with renewable seat and disc, 175 PSI WWP.

c. Victaulic Series 717, UL Listed, FM approved, ductile iron body, grooved ends or wafer style; welded-in nickel or rubber seat; stainless steel, elastomer coated ductile iron or bronze disc; spring actuated; stainless steel spring, pin and thrust bearing; 250 PSI WWP.

3. Gate valves:

a. 2-1/2" and larger: Victaulic Series 771, UL Listed and FM approved, cast iron body, solid wedge, outside screw and yoke, grooved ends or flanged, 250 PSI WWP, pre-grooved stem for supervisory switch mounting.

4. Butterfly valves:

a. Victaulic Series 705 with grooved ends, wafer or lug style, UL Listed, FM approved, 300 PSI WWP, ductile iron body, bubble-tight shutoff rated with weatherproof actuator housing and internal supervisory switches, ductile iron disc, stainless steel stem, EPDM molded-in pressure-responsive seat. The valve

stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.

5. Globe and Angle Valves (Trim and Drain Use):

   a. 175 PSI minimum working pressure, UL Listed, 2" and smaller: bronze, renewable nitrile rubber seat disc, screwed.

6. Hose Valves:

   a. 2-1/2" Angle hose valve: 2-1/2" angle hose valve, UL listed and FM approved, cast brass, 300 lb. rated, hose thread outlet, polished brass finish with cap and chain. Potter-Roemer 4065 or approved equal.

7. Straight Globe Valves (Roof Manifolds and Pumped Test Header):

   a. 2-1/2" straight globe valve, UL listed, cast brass, 300 PSI, hose thread outlet, cap and chain. Potter-Roemer 4115 or approved equal.

8. Ball valves:

   a. Victaulic Series 728, threaded or grooved, UL listed, FM approved, bronze body and stem, two piece, weatherproof actuator housing and internal supervisory switches, 300 psi WWP, chrome plated brass ball, PFTE seat ring.

9. Water Motor Alarm: Victaulic Series 760, hydraulically operated impeller type alarm with aluminum alloy red enameled gong and motor housing, nylon bearings and inlet strainer.

10. Electric Alarm: Electrically operated horn/strobe device with pressure alarm switch. Interlock horn/strobe operation with fire alarm system.

2.2 PIPE AND FITTINGS

A. Interior Standpipe and Sprinkler Pipe and Fittings:

1. Schedule 40 ASTM-135, electric-resistance welded steel pipe for pipe sizes 2" and smaller.

2. Schedule 10 ASTM-135, electric-resistance welded steel pipe suitable for roll grooving for pipe sizes 2-1/2" and larger.

3. Sprinkler piping and fittings shall be Schedule 40 galvanized or ASTM-A135 ERW black steel for dry pipe systems and pre-action systems, where piping is exposed to weather or located in a corrosive environment.

4. Fittings:

   a. Mechanical couplings: Roll or cut groove rigid type by Victaulic, Central Grooved, or Anvil. Couplings consist of two ductile iron housing segments, pressure

responsive elastomer gasket, and ASTM A449 zinc-electroplated steel bolts and nuts.

1) Rigid: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity, support and hanging in accordance with NFPA 13. Couplings shall have full pad to pad contact when installed correctly. Victaulic Style 009, 107N or equivalent.

2) Flexible: Use in locations where vibration attenuation and stress relief are required. Victaulic Style 177 Installation-Ready, Style 77 or equivalent.

b. Class 125 in accordance with ANSI B16.4 or Class 250 in accordance with ANSI B16.3 cast iron sprinkler fittings - screwed, flanged, or short-pattern grooved-end, Victaulic Firelock, or equivalent.

c. Victaulic Installation-Ready fittings for Schedule 40 and Schedule 10 grooved end steel piping sizes 1-1/4" through 2-1/2". Fittings shall consist of a ductile iron housing with Installation-Ready end complete with prelubricated Grade "E" EPDM Type A gasket and ASTM A449 electroplated steel bolts and nuts. UL Listed for a working pressure of 300 PSI and FM approved for working pressure of 365 PSI.

d. All fittings shall be by the same manufacturer.

B. Drain Piping:

1. Schedule 40, A106 or A120, galvanized pipe

2. Fittings: Class 250 malleable iron, screwed with galvanized coating

2.3 HANGERS AND SUPPORTS

A. Acceptable manufacturers: Anvil, B-line, Viking, Reliable, Empire, Fee and Mason. Anvil model numbers are used to establish level of product quality.

B. Provide UL Listed and FM approved hangers.

C. Hangers:

1. Anvil #260 MSS, Type 1 for pipe 2-1/2" through 12"

2. Anvil Figure #104, Type 6, adjustable split ring for pipe less than 2"

3. Anvil #69 for pipe 1/2" through 2"

D. Clamps:

1. Riser Clamps: Anvil #261, MSS Type 8, at floor slab penetrations to support risers

2. C-Clamps: Anvil #92 with retainer clip, MSS Type 23

3. Malleable Beam Clamps: Anvil Figure #218, MSS Type 30

E. Sidewall Hanger Bracket: Tolco Figure 58 Threaded side beam bracket, carbon steel, UL and FM approved; fastener and rod sizes as recommended by manufacturer based on pipe size and weight.

F. Inserts:

1. Concrete insert: Anvil Figure #281, MSS Type 18, universal concrete insert, adequately sized and correctly positioned to support full load.

2. Lightweight concrete: Anvil #285.

3. Continuous Concrete Insert: Anvil Powerstrut #PS-349, pregalvanized.

4. Power Insert: HILTI HDI expansion anchor. Use in conjunction with all thread rods.

5. Power inserts shall not be used in post tension construction unless approved by Structural Engineer.

2.4 SPRINKLER HEADS

A. Acceptable Manufacturers: Victaulic, Globe, Reliable Sprinkler Company, Automatic Sprinkler Company, Viking, Tyco Fire Products.

B. Sprinklers shall be glass bulb type, with hex-shaped wrench boss integrally cast into the sprinkler body. Sprinkler wrenches shall be provided by the sprinkler manufacturer.

C. Split-ring type escutcheons are not acceptable.

1. Escutcheons and guards shall be Listed and supplied with the sprinkler head by the sprinkler manufacturer.

D. Sprinkler heads shall be UL Listed and FM approved. Concealed type quick response sprinkler head may be UL listed only.

E. Provide quick response heads in all light hazard areas and in concourses.

F. Provide sprinkler heads as follows:

1. Brass U-Right: Victaulic V2703, bulb type, 1/2" orifice, upright. Quick response Victaulic V2704.

2. Chrome Pendent: Victaulic V2707, bulb type, 1/2" orifice, pendent. Quick response Victaulic V2708.

3. Horizontal Sidewall: Victaulic V2709, solder type, 1/2" orifice. Quick response Victaulic V2710, 1/2" bulb type.

4. Concealed: Victaulic V38, bulb type, 1/2" orifice. Quick response bulb type, 1/2" orifice.

5. Semi-Recessed: Victaulic V2707 (standard) and V2708 quick response bulb type 1/2" orifice.

6. Dry Pendent: Victaulic V3605 (standard coverage), bulb type, 1/2" orifice.

7. Concealed Dry Pendent: Victaulic V33.

8. Provide polyester coated heads in corrosive environments and exterior over hangs.

G. Provide one sprinkler cabinet with 6 extra sprinkler heads and sprinkler wrench for emergency use. Locate cabinet in maintenance area. Provide a minimum of two extra sprinkler heads of each type sprinkler head used for the project. Add an extra sprinkler cabinet if necessary to house the spare heads.

2.5 SWITCHES

A. Provide supervisory switches for all fire/sprinkler system control valves unless noted otherwise.

B. Flow switch: System Sensor WFDN Series or Potter Model No. VSR vane type flow switch with pneumatic retard adjustable from 0 to 70 seconds, complete with two sets of single pole, double throw (SPDT) switches; UL Listed and FM approved.

C. Supervisory switch: System Sensor OSY2 or Potter Model No. OSYSU-2 with two sets of SPDT contacts; UL Listed and FM approved, for 1/2-inch to 12-inch valves. Provide rod extension for 3" and larger valves as needed for proper operation.

2.6 WATER FLOW ALARMS

A. Connect water flow alarms to alarm check valves with bell located on outside of building. Provide other flow switches as shown on drawings and connect to fire alarm system.

B. Drain valves: Provide drain valves as required by NFPA 13.

2.7 INSPECTORS TEST ASSEMBLY

A. Cabinet: Potter-Roemer #1812-C white baked enamel, minimum 6-1/2" deep, steel box with full acrylic panel.

B. Test module: Victaulic "Test Master II" Style 720, threaded , with combination sight glass and 1/2" orifice.

C. Finish: Paint exterior cabinet frame to match wall surface and color.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate installation to avoid interference with other systems.

B. Provide power and interlock wiring under and in accordance with Division 26.

3.2 PIPE INSTALLATION

A. Install sprinkler pipe a minimum of 12" above top of ceiling to allow for removal of ceiling tile and lighting fixtures and for access to equipment above the ceiling.

B. Support vertical pipe risers at 12' maximum distance or at least once at each floor.

C. Use hanger types as specified in Part 2 above. This shall overrule hanger types outlined in NFPA 13.

D. Hanger spacing shall be in accordance with NFPA 13.

E. Provide hangers on all arm outs of 12" or more.

F. Seal penetrations of fire rated walls and floors in accordance with U.L. Fire Resistance Index for Through-Penetration Firestop Systems. Coordinate requirements with Division 07.

G. Provide trapeze type hangers where necessary to support pipe when structural steel or clear path to deck is not directly above piping for support.

H. Hydrostatically test all piping and systems per NFPA requirements.

I. Install at least at every other floor test tees with plugs for pressure-regulating devices testing.

J. Grooved Joints: Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from the pipe end to and including the groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service.

   1. A factory trained representative of the coupling manufacturer shall provide on-site training for the contractor's field personnel in the use of grooving tools, application of the groove, and product installation.

   2. The representative shall periodically visit the job site and review the installation to ensure best practices in grooved joint installation are being followed.

   3. Contractor shall remove and replace any improperly installed or damaged products.

3.3 SPRINKLER INSTALLATION

A. Install sprinkler heads and required piping in areas such as concealed spaces, and other special areas and spaces as required by NFPA 13, NFPA 101, and the IBC.

B. Sprinkler heads shall be of the intermediate or high-temperature rating defined in NFPA 13, Chapter 8, when placed near heat sources including heating ducts, unit heaters, steam piping, concealed spaces, skylights walk-in coolers with automatic defrosting and similar spaces as designated and as defined in NFPA 13.

C. Provide drain valves, pipes and test connections as required by NFPA 13. Pipe drain lines and test connections to outside building or as shown and detailed on Drawings. Originate test lines from most hydraulically remote point of each sprinkler zone.

D. Install sprinkler heads centerline of corridors and locate in the center of the ceiling tiles. Install sprinkler heads in other designated spaces in the center of the ceiling tiles and symmetrically locate with other heads within the ceiling. Do not install sprinkler heads in other locations any closer than six inches to any ceiling grid or wall.

E. Do not install any sprinkler heads that have been dropped, damaged, or show visible loss of fluid. Sprinkler heads with cracked bulbs shall not be installed.

F. Sprinkler bulb protectors shall be removed by hand after installation. Do not use tools or any other device to remove the protector that could damage the bulb.

G. Provide head guards on heads in Feildhouse and below 7'-6" above floor or walkway and where heads may be subject to damage.

H. When exposed sprinkler piping is painted the installed sprinkler heads shall be bagged and banded to protect the sprinkler heads. Do not use tape for bagging the sprinkler heads. If tape or paint gets on the sprinkler head, the sprinkler head will lose its listing and shall be replaced.

3.4 CLOSEOUT ACTIVITIES

A. Refer to Division 01 for submittals, documentation and additional requirements for this project.

B. Demonstrate proper operation of equipment to Owner's representative and AHJ.

C. Demonstrate operation of fire systems to AHJ and Owner's representative.

1. Use operation and maintenance manual during demonstration.

2. Conduct walking tour of project.

3. Briefly describe function, operation and maintenance of each component.

D. Training: Train owner's personnel on operation and maintenance of system using operation and maintenance manuals as required. Supplement training with manufacturer's training personnel when required or requested by the owner.

END OF SECTION

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Common work results for requirements specifically applicable to Division 22.

B. Requirements of Division 01 Specifications, General Provisions of the Contract and General and Supplementary Conditions apply to this Division.

1.2 REGULATORY REQUIREMENTS

A. Perform Work specified in Division 22 in accordance with the codes and standards listed below of the latest applicable edition adopted by the authority having jurisdiction. Where these Specifications are more stringent, they shall take precedence. In case of conflict, obtain a decision from the Architect.

1. NFPA 101: Life Safety Code
2. ANSI Handicapped Code-A117.1
3. U.L Fire Resistance Index
4. ASTM E814-08B: Standard Test Method for Fire Tests of Penetration Firestop Systems
5. IBC: International Building Code, with Mechanical and Plumbing Codes
6. NFPA 54: National Fuel Gas Code
7. NFPA 70: National Electrical Code
8. NFPA 72: National Fire Alarm and Signaling Code
9. NFPA 101A: Guide on Alternative Approaches to Life Safety
10. NFPA 101B: Standard on Means of Egress for Buildings and Structures
11. NFPA 241: Standard for Safeguarding Building Construction, Alteration and Demolition Operations
12. Special regulations, supplements, and amendments of the State and/or local authorities having jurisdiction.

1.3 REFERENCE STANDARDS

A. AGA: American Gas Association

B. ANSI: American National Standards Institute

C. ASME: American Society for Mechanical Engineers

D. ASTM: American Society for Testing and Materials

E. AWWA: American Water Works Association

F. MSS: Manufacturer's Standardization Society of the Valve and Fitting Industry

G. NEMA: National Electrical Manufacturers' Association

H. NFPA: National Fire Protection Association

I. UL: Underwriters' Laboratories, Inc.

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01 including required number of copies.

B. Include Products as specified in the individual sections of Division 22.

C. Group submittals to include complete information of related systems, products, and accessories in a single submittal.

D. Prepare shop drawings completely independent of the Engineer of Record's CADD files. Should the Contractor or Vendor wish to use the Engineer of Record's CADD files or Revit model as the basis for developing their shop drawings, a release form, obtainable from the Engineer or Architect, must be signed.

E. Submit copies of shop drawings in accordance with Division 01, for plumbing equipment and piping systems including:

1. Concrete pads and foundations including anchor bolt and sleeve locations.

2. Prepare and submit coordination drawings specified herein. Facilitate the coordination effort with other trades, specifically Divisions 21, 23, 26 and 28 and include, but not be limited to the following:

a. Electrical Switchgear Rooms

b. Mechanical Rooms

F. Brochures: Submit manufacturer's product data and brochures including:

1. Complete descriptions.

2. Illustrations and wiring diagrams.

3. Rating data, accessories, dimensional data, and applicable options and features marked for the specific items scheduled on drawings and specified herein.

4. Capacities stated in the terms specified

5. Performance and rating data for plumbing equipment and performance curves for pumps.

1.5 QUALITY ASSURANCE

A. Lead Free: All wetted surface of pipe, fittings and fixtures in potable water systems shall have a weighted average lead content equal to or less than 0.25% per the Safe Drinking Water Act (Section 1417) as amended January 4, 2011.

B. NSF Compliance: NSF/ANSI 61 and/or NSF/ANSI 372 for valve materials for potable-water service. Valves for domestic water must be 3rd Party Certified.

1.6 FIELD CONDITIONS

A. Layouts indicated on drawings are diagrammatical and intended to show relative positions and arrangement of piping and equipment. Coordinate work with other trades and with measurements obtained at the job site, as applicable, prior to installation. Generally, install work in locations shown on Drawings. Provide necessary rises, drops, and offsets to fit in the available space unless prevented by Project conditions.

B. If prevented by project conditions, prepare drawings showing proposed rearrangement of Work, including changes to Work specified in other sections. Obtain permission of the Architect before proceeding.

C. Place anchors, sleeves, and supports prior to pouring concrete or installation of masonry work.

D. Cause as little interference or interruption of existing utilities and services as possible. Schedule work which will cause interference or interruption in advance with Owner and all affected trades.

E. Determine sizes and verify locations of existing utilities on or near site.

F. Keep roads and other spaces clear of materials and debris.

G. Visit site and be informed of conditions under which Work must be performed.

H. Locate equipment requiring periodic servicing so that it is readily accessible. Provide means of service access, following appropriate manufacturer's recommended service clearance space or, as applicable, means of access using duct, wall, or ceiling access doors.

I. Install piping to leave sufficient space for AHJ inspection of wall construction. Coordinate pipe routing with other trades including but not limited to Divisions 21, 23, 26 and 28.

1.7 FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required to perform Division 22 work.

1.8 COORDINATION DRAWINGS

A. Prior to commencement of installation, assist in preparation of coordination drawings for work under this Division, as specified in Division 01. Fully cooperate with persons coordinating and performing work under other Divisions.

B. Drawings shall not be formally submitted but shall be kept on site for reference. Notify the Architect of conflicts that cannot be resolved.

1.9 COMPLETENESS OF WORK

A. The Contract Documents depict plumbing systems which are intended to be complete and functioning systems. All products, materials, and labor necessary to render a fully functional system to fulfill the design intent shown on the documents shall be provided by the Contractor.

B. Catalog numbers referenced throughout the Division 22 Drawings and Specifications are intended to convey a general understanding of the type and quality of the product required. Where written descriptions differ from information conveyed by a catalog number, the written description shall govern. No extra shall be allowed because a catalog number is found to be incomplete or obsolete.

1.10 PRODUCT SUBSTITUTIONS

A. Comply with provisions of Division 01.

1.11 RECORD DRAWINGS

A. Provide record drawings that illustrate the work of Division 22 as finally constructed. Deliver record drawings to the Architect in a form suitable for reproduction. Comply with the provisions and requirements of Division 01.

B. Record drawings shall reflect all changes made to the Contract Documents, whether generated by addenda, change orders, or field conditions. Maintain a daily record of these changes and keep current set of drawings showing these changes.

C. Deliver record drawings to Architect within 30 days of Substantial Completion.

1.12 OWNING AND OPERATING MANUALS

A. Comply with the requirements of Division 01, but provide a minimum of three sets.

B. Manuals shall include clear and comprehensive instructions with appropriate graphics and project specific marked data to enable owner to operate and maintain all systems specified in this Division.

C. Copies of reviewed submittals for furnished equipment shall be included.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPORTS

A. Structural steel for supports: ASTM A36.

B. Use galvanized members installed in areas of high humidity or condensation, and outside.

C. Furnish other members with shop coat of red primer.

D. Retouch primer after field welding.

2.2 FLASHINGS AND COUNTERFLASHINGS

A. Furnish materials and coordinate installation for flashing and counterflashing roof penetrations for vents, pipe, drains, and ducts.

B. Materials:

1. Sheet metal: 24-gauge minimum ASTM A525, Class G90

2. Sheet lead: 3 pounds per square foot

3. Stainless steel: Minimum 20 gauge

4. Sheet copper: 24 OZ/SF

C. Vent Stack Fitting (threaded roof coupling): Josam 26450 or Jay R. Smith 1750.

2.3 WALL AND CEILING ACCESS PANELS

A. Style and type as required for material in which installed.

B. Size: 12"x12" minimum, as indicated, or as required to allow inspection, service and removal of items served.

C. 14-gauge minimum sheet metal for doors, 16-gauge frames of cadmium-plated or galvanized construction. Doors shall have expanded plaster rings where located in plaster walls or flanged finish where located in drywall or block construction.

D. Panels shall have spring hinges with screwdriver locks in non-public areas. Key lock, keyed alike, for panels in public areas.

E. Prime painted or rust inhibitive paint finish.

F. UL labeled when in fire-rated construction, 1-1/2 hour rating.

G. Provide in walls, floors, and ceilings to permit access to all equipment and piping requiring service or adjustment. Examples of such equipment needing access are valves, and equipment needing periodic or replacement maintenance.

H. Furnish and locate access panels under this Division. Coordinate with trades who are responsible for building system in which panels are to be installed.

I. Acceptable manufactures: Milcor, Nystrom, Karp, J.L. Industries, or Williams Brothers.

1. For masonry and drywall construction: Milcor Style M

2. For plastered masonry walls and ceiling: Milcor Style K

3. For ceramic tile or glazed structural tile: Use stainless steel panels

2.4 PIPE ENCLOSURES

A. For exposed vertical piping in kitchen: 18 gauge stainless steel (type 302) with No. 4 finish.

1. Extend from 2" above ceiling to equipment or island partition

2. Size covers to contain number of pipes served

B. Minimize number of covers by enclosing maximum number of pipes in each drop.

C. Anchor to equipment or partition.

D. Fasten seams and joints with stainless steel pop rivets.

E. Provide 1-1/2" ceiling flange as closure.

2.5 PROTECTION AGAINST CONTACT

A. Metallic piping, except for cast iron, ductile iron and galvanized steel, shall not be placed in direct contact with steel framing members, concrete or cinder walls and floors or other masonry. Metallic piping shall not be placed in direct contact with corrosive soil. Where sheathing is used to prevent direct contact with the soil, the sheathing shall have a thickness of not less than 0.008 inch (8 mil) and the sheathing shall be made of plastic.

B. Where piping penetrates rated walls, partitions and floors, sleeves and fire safing shall be used to maintain the integrity of the wall or floor.

2.6 SLEEVES

A. Materials:

1. Concrete floors, concrete and masonry walls: 18 gauge galvanized steel tube with welded longitudinal seam or Sch. 10 galvanized steel pipe.

2. Drywall partitions: 18 gauge galvanized steel sheet metal or Sch. 10 galvanized steel pipe.

3. Cast iron: Cast or fabricated pipe equivalent to ductile iron pressure pipe with plain ends and integral waterstop, unless otherwise indicated.

4. Stack Sleeve Fittings: Manufactured, cast iron sleeve with integral clamping flange. Include clamping ring, bolts and nuts for membrane flashing. Provide under deck clamp with clamping ring and set screws.

B. Sleeves shall be sized such that the annular space between outside surface of pipe or pipe insulation and the inside surface of the sleeve is not less than 1/2". Provide larger annular space if required by firestopping product installation instructions or water proofing seal at exterior wall penetrations.

C. Sleeves supporting riser piping 4" and larger shall have three 6" long reinforcing rods welded radically at 120 degree spacing to the sleeve and shall be installed with the rods embedded in the concrete slab as the floor slabs are poured.

D. Exterior wall and floor penetrations shall be sleeved and sealed with a Link Seal Modular Seal by GPT Industries or Flexicraft Industries.

1. Exterior wall and floor penetrations: Install Link Seal Modular Seal by GPT or Flexicraft Industries. Seal shall be suitable for use in direct ground contact, water or atmospheric conditions with EPDM seal element. Provide Nitrile rubber seal element where subject to oils and fuel. All bolts, nuts and fasteners shall be Steel with 2-part Dichromate corrosion inhibiting coating or Type 316 Stainless steel.

2.7 ESCUTCHEON PLATES

A. Provide B & C No. 10 or equal chrome plated escutcheon plates where pipes penetrate partitions or ceilings in finished spaces or areas.

PART 3 - EXECUTION

3.1 EXCAVATING AND BACKFILLING

A. Contractor shall review Divisions 31 and 33 and shall perform excavation and backfilling in accordance with the most stringent requirements. Contractor shall request clarification before proceeding if there are conflicting instructions.

B. Contract Documents show the approximate location of underground utilities known to exist in the area of construction. Contractor shall determine the exact location of utilities.

1. Locate and uncover existing utilities which require new connections before trenching in the vicinity of indicated utility connection.

2. Clear all vegetation and other objectionable material from the area required for the excavation and backfill operations. Disposal of material removed by the clearing operation shall be approved by the Owner's representative.

C. Provide trenching, excavating, and backfilling necessary for performance of work indicated in Contract Documents.

D. Excavate to depths indicated on the drawings or as necessary to permit the installation of pipe, bedding, backfill, structures or appurtenances. Provide a firm, undisturbed, uniform surface in the bottom of trenches. Where excavation exceeds the required depth, bring the excavation to proper grade through the use of an approved incompressible backfill material. Store excavated material and dispose of surplus excavated material.

1. Excavate trench to sufficient depth to permit a minimum of 36" of cover over the top of the pipe unless otherwise required by pipe elevations indicated on the Drawings. The trench width shall be 18" plus the diameter of the pipe and/or the largest bell.

E. Trenching and excavation shall be unclassified. No extra will be paid in the event that rock is encountered.

1. Should rock excavation be required, use only experienced personnel for blasting.

2. Exercise extreme care when blasting with signals of danger given before firing any charge.

3. Conform to and obey all public authority regulations for the protection of life and property.

F. Provide sheathing, shoring, dewatering, and cleaning necessary to keep trenches and their grades in proper condition and to meet applicable codes.

G. Provide a minimum of 6" of No. 67 crushed stone or clean sand bedding, or equal, in the bottom of the trench to maintain the required grade and continuous support of the bottom quadrant of the pipe. On bell and spigot piping, dig bell holes so bottom of bells do not support pipe.

H. Upon completion of excavation, and prior to the laying of the pipe, the trench bottom shall be brought up to the required elevation with min. 6" pipe bedding. Pipe bedding shall be select material deposited in the trench, and shall be compacted, leveled off, and shaped to obtain a smooth compacted bed along the laying length of the pipe. Material for pipe bedding shall comply with local codes. In absence of local code requirements the bedding shall be bank sand or select back fill material approved by the Architect. Any material used shall pass a 1/4 inch screen.

I. Clean and inspect pipe for defects before lowering into trench for assembly. Install pipe in accordance with provisions of Contract Documents and with the recommendations of the pipe manufacturer.

1. Ensure pipe is of proper strength and classification for specified service. Discard damaged or defective pipe discovered during pipe laying operations.

2. Maintain alignment and grade during layout operation. Use acceptable method for maintaining grade and alignment to produce desired results.

J. Where crushed stone backfill is required, use No. 67 stone, clean sand or equal.

K. After bedding has been shaped and the pipe assembled, place crushed stone carefully around the pipe and to a point 12" above the pipe. Backfill above this point shall be as described below:

1. Backfill areas of vehicular traffic shall consist entirely of crushed stone and compacted crusher run material.

2. Backfill for shoulders of roadways, sidewalk, and slab on grade structures shall consist entirely of crushed stone.

3. Backfill areas not subject to vehicular traffic may consist of suitable excavated material as described above.

L. Where crushed stone is not required, suitable excavated material may be utilized. This includes fine, dry earth or a mixture of earth and shot rock. Rocks larger than 6" in any dimension may not be included in any portion of the backfill material.

M. Trenches shall be backfilled only after piping has been inspected, tested, and approved by the Architect. All backfill material shall be placed in the trench either by hand or by approved mechanical methods. The compaction of backfill material shall be accompanied by tamping, with hand tools or approved pneumatic tampers, by using vibratory compactors, by puddling, or by any combination of the three. The method of compaction shall be approved and all compaction shall be done to the satisfaction of the Architect. Backfill completely around pipe, including 18" above the pipe, with suitable bank sand, tamped in 4" layers under, around, and over pipe. Water down backfill as required. The remainder of the backfill shall be select backfill material tamped at intervals of no more than 12" depths. All materials to be used as selected material backfill shall be approved by the Architect. If, in the opinion of the Architect, the excavated material does not meet the requirements of selected material, the Contractor shall be required to screen the material prior to its use as selected material backfill. Material used in the upper portion of the backfill or subgrade shall not contain stone, rock, or other material larger than six inches in its longest dimension. No wood, vegetable matter, or other material which, in the opinion of the Architect, is unsuitable shall be included in the backfill. The upper 24" of backfill may be water jetted, if desired. Backfill shall be brought up to finish grade identified on the Architectural Drawings, including additional backfill required to offset settlement during consolidation.

3.2 CUTTING AND PATCHING

A. Repair or replace damage caused by cutting or installation of work specified in Division 22.

B. Perform repairs with materials which match existing and install in accordance with the appropriate section of these specifications.

3.3 FLASHING AND COUNTERFLASHING

A. Counterflash pipes where penetration of roofs and outside walls occur.

3.4 CONNECTION TO EQUIPMENT FURNISHED BY OWNER

A. Connect or install equipment shown on plumbing drawings that requires plumbing connections.

B. Provide piping, shutoff valves, unions, and other piping appurtenances required for a complete installation. Provide backflow preventers and/or pressure reducing valves where required by the equipment design or local code. All components shall be line size unless noted otherwise.

3.5 DELIVERY, STORAGE, AND PROTECTION

A. Insofar as possible, deliver items in manufacturer's original unopened packaging. Where delivery in original packaging is not practical, provide cover and shielding for all items with protective materials to keep them from being damaged. Use care in loading, transporting, unloading, and storing to keep items from being damaged.

B. Store items in a clean, dry place, and protect from damage. Plumbing equipment may not be staged or stored outdoors unless intended for outdoor use.

C. Protect nameplates on motors, pumps, and similar equipment. Do not paint or insulate over nameplate data.

D. Protect plumbing fixtures and brass or chromium plated trim, valves and piping from damage. Cover fixtures during work of finishing trades.

E. Keep dirt and debris out of pipes.

F. Repair, restore, and replace damaged items.

G. Cover factory finished equipment during work of finished trades.

3.6 SLEEVES

A. Floors and Roof Slabs: Sleeve all pipe penetrations including mechanical equipment rooms and other wet areas. Extend sleeve 2" above finished floor and roof, except piping within pipe chases. Sleeve shall be flush with underside of floor unless required for cast iron clamping ring to be secured.

B. Masonry or concrete walls: Sleeve all pipe penetrations. Sleeves shall be flush on both sides of wall.

C. Non-Rated Drywall partitions: Sleeves are not required, except in piping systems above 160 degrees F. Voids between pipe, pipe insulation and drywall shall be sealed with appropriate joint sealant material.

D. Seal voids between outside surface of sleeve and wall, partition or floor. Seals shall be airtight.

E. For all fire rated walls, floors and partitions install piping, insulation and sleeves in strict accordance with applicable U.L. Fire Resistance Index assembly and with firestop manufacturer's installation instructions for floor or partition penetrations. Coordinate instillation and firestop material with Division 07 and Firestop Manufacturer's installation instructions.

F. Clearance between sleeve and pipe: Minimum of 1/2 inch for hot piping and 1 inch for cold piping or as otherwise dictated by U.L. Fire Resistance Directory.

G. Wall Penetrations not sleeved or firestopped:

1. Seal voids between pipe and partition with appropriate joint sealant material. Seals shall be airtight.

H. Core drilled holes in concrete floors: Sleeves are not required. Seal airtight and to maintain the floor rating integrity.

3.7 ESCUTCHEON PLATES

A. Provide chromium plated escutcheon plates for exposed uninsulated pipes projecting through floors or wall in finished spaces. Mechanical rooms, storage rooms, electric closets and housekeeping closets are not considered finished spaces.

B. Clearance between sleeve and pipe: Minimum of 1/2" for hot piping and 1" for cold piping or as otherwise dictated by the UL Fire Resistance Directory.

3.8 CLEANING PLUMBING SYSTEMS

A. General Cleanup:

1. Upon completion of contract and progressively as work proceeds, clean up dirt, debris, old materials, etc., and remove from site, keeping premises in neat and clean condition to satisfaction of the Architect. See Division 01 of specifications for further requirements.

2. Seepage, discoloration or other damage to parts of the building, its finish, or furnishings due to Contractor's failure to properly clean piping systems shall be repaired without cost to the Owner.

B. Factory Finishes:

1. Clean items with factory finishes. Touch up bare places, scratches and other minor damage to finishes. Use only factory supplied paint of matching color and formula. If finishes are badly damaged or if there are many damaged, scratched or bare places, refinish the entire item.

C. Domestic Water System:

1. Flush system progressively by opening building operable valves, faucets and hose bibs and permitting flow to continue from each unit until water runs clear.

2. Sterilize system in accordance with requirements of State Department of Public Health by the following method or other methods acceptable to authority having jurisdiction.

   a. Introduce chlorine or a solution of calcium or sodium hypochlorite. Fill lines slowly and apply sterilizing agent at a rate of 50 ppm of chlorine as determined by residual chlorine tests at ends of lines. Open and close all valves while system is being chlorinated.

   b. After sterilizing agent has been applied and left standing for 24 hours, test for residual chlorine at ends of lines. If test indicates there is less than 25 ppm, repeat sterilizing process.

   c. After system has been standing 24 hours and test indicates at least 25 ppm of residual chlorine, flush out system until all traces of chemical used are removed.

3. Have local health department check and approve system before connecting it to existing water system.

4. If the domestic water system is sterilized more than 24 days prior to the owner/user taking beneficial occupancy, the entire water system shall be re-sterilized so that it is tested clean as noted above at the time of occupancy.

   a. All piping, dead legs, safety showers, eyewashes, and faucets shall be opened and thoroughly flushed for at least 15 minutes prior to re-sterilization.

5. The domestic water system shall be tested for the presence of Legionella by a third party testing laboratory certified and experienced in Legionella testing prior to the owner taking occupancy. The location and results of testing must be documented and presented to the owner.

6. If only a portion of the domestic water system was opened for repair or other construction such that the system was subjected to water pressure changes or stagnation, the water system or portions thereof shall be thoroughly flushed and sterilized by chlorination as described above.

3.9 TESTING PLUMBING SYSTEMS

A. Test all systems and equipment installed to demonstrate proper operation.

B. Advise the Architect of scheduled systems testing and completed system demonstration/operation schedules so that he may witness, if desired.

C. Correct and retest work found defective or leaking when tested.

D. Make repairs to piping systems with new materials. Peening, doping, or caulking of joints or holes will not be acceptable.

E. Domestic Water Piping: Test hot and cold water piping systems upon completion of rough-in, before fixtures are connected, at a hydrostatic pressure of 125 psig or 150% of working pressure whichever is greater for a period of two hours.

F. Natural Gas Piping: Test piping with air, CO2, or nitrogen at 100 psi pressure for two hours without leaking.

G. Flush Valves: Test all flush valves for proper operation.

H. Drainage and vent system

1. Test plug opening(s) to permit system to be filled with water, and subject system to a 10 foot head of water pressure. System shall hold water for 30 minutes without a drop in water level in a 4 inch diameter standpipe, and without visible leakage.

2. If system is tested in sections, a minimum head of 10 feet shall apply.

I. All plumbing equipment and systems must be balanced by a certified third party as noted in Division 23 Testing and Balancing requirements.

J. Records of Testing: Maintain records of system testing and results thereof. Deliver results as part of the project closing file and on an intermediate basis as requested by the Architect.

3.10 INFECTION CONTROL REQUIREMENTS

A. Coordinate with the Owner the exact requirements for the infection control measures to be executed and performed during the course of this Project.

B. Prior to execution, present to the Owner for approval a written execution plan for each infection control measure.

C. Coordinate infection control measures as needed with all other trades and disciplines.

D. Provide documentation of infection control measures to the Owner, as required and specified in the ICRA.

END OF SECTION

SECTION 22 05 23
VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Valves for plumbing systems.

1.2 SUBMITTALS

A. Submit product data for review in accordance with the requirements of Division 01. Valves used or indicated to be used in domestic potable water systems must be lead free in accordance with the Reduction of Lead in Drinking Water Act effective January 4, 2014.

1.3 QUALITY ASSURANCE

A. Lead Free: All wetted surface of pipe, fittings and fixtures in potable water systems shall have a weighted average lead content equal to or less than 0.25% per the Safe Drinking Water Act (Section 1417) as amended January 4, 2011.

1. NSF Compliance: NSF/ANSI 61 and/or NSF/ANSI 372 for valve materials for potable-water service. Valves for domestic water must be 3rd Party Certified.

B. Bronze body valves:

1. Materials for pressure containing parts: ASTM B-62 (less than 200 psi), B-61 (200 psi and above)

2. Design, workmanship, testing: MSS-SP-80

C. Iron body valves:

1. Materials for pressure containing parts: ASTM A126, Grade B

2. Face-to-face and end-to-end dimensions: ANSI B16.10

3. Design, workmanship, testing: MSS-SP-70, 71

D. Butterfly valves:

1. Face-to-face and end-to-end dimensions: MSS-SP-67

E. Pressure Reducing Valves:

1. Pressure reducing valves 2" and less to have bronze body construction meeting ASSE Standard B356, ANSI A112.26.2.

2. Pressure reducing valves 2-1/2" and up to be cast iron construction, ASTM A126 Class B. Valve to be epoxy coated inside and outside. Unit to have low flow bronze bypass valve.

F. Valve stems: ASTM B584-78, Class 13C (cast silicon brass), ASTM B-371-79, Alloy A (rolled silicon brass), or other material equally resistant to dezincification.

G. Pressure castings: Free of impregnating materials.

H. Valve name or trademark and working pressure stamped or cast into body.

I. Standard for 200 PSI and 300 PSI valves with metallic seats: ASTM B61-76.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Iron body valves: Nibco, Apollo, Stockham, Crane, Milwaukee, Dezurik, Mueller or Kennedy

B. Bronze body valves: Nibco, Apollo, Stockham, Milwaukee, Dezurik or Kennedy

C. Butterfly valves: Nibco, Apollo, Stockham, Crane, Milwaukee, Mueller, Victaulic (grooved only) or Dezurik

D. Ball valves: Nibco, Apollo, Watts, Milwaukee, Jamesbury or Hammond

E. Pressure Reducing Valves: Watts, Apollo, Nibco.

2.2 MATERIALS

A. Nibco Figure numbers are indicated below unless noted otherwise:

B. Check Valves:

1. Domestic Water:

a. 2" and less, Figure T-413-Y-LF, or S-413-Y-LF, threaded or solder, Lead Free silicone bronze body, Class 150, PTFE seat

b. 2-1/2" and up: Iron body, bronze alloy disc, bronze alloy or Buna-N seat, stainless steel spring, flanged, Class 125, Lead Free, globe style, F-910-LF; or F-960-LF, Class 250.

C. Ball Valves

1. Domestic Water

a. 2" and less, Figure T585-80-LF or S-585-80-LF, 2-piece, full port, 600 psi WOG, PTFE packing seal and seat ring, lead free silicone bronze alloy body and ball.

b. 2-1/2" and up, Watts G4000-FDA-Lead Free-200 psi, 2 piece, full port, cast iron, flanged, heat fused epoxy coating, stainless steel ball and stem, PTFE seat, Class 125 meeting MSS-SP-72-92 or equal.

2. Provide ball valves with locking handles.

3. Provide extended lever for insulated service.

D. Butterfly Valves - 2-1/2" And Up:

1. Domestic Water: Figure LD-2000, ductile iron body, Lead Free, lug type, 200 psi, Class 125, EPDM liner and seals, and aluminum bronze disc, meeting AWWA C504-88.

2. Butterfly valves rated bubble tight for dead end service at full pressure in both directions without the need for downstream blind flange.

3. Provide hand wheel and closed housing worm gear on valves 6 inches and larger. Provide clamp lock hand lever operators on valves less than 6 inches.

4. Grooved piping: Victaulic Series 608N, brass body, rated bi-directionally to 300 psi, aluminum bronze disc, fluoroelastomer seat, -20 degrees F to +250 degrees F temperature range.

E. Pressure Reducing Valve:

1. 2" and less, Watts Series U5 or 223 Lead Free with integral or attached strainer. 300 psi inlet pressure and bronze body construction.

2. 2-1/2" and up, Watts ACV 115E Lead Free automatic control valves with a 263 reducing valve. 400 psi inlet pressure with stainless steel seats. Cast iron body with epoxy coating inside and outside.

F. Valve connections: Two inches and smaller - threaded; 2-1/2 inches and larger - flanged.

G. Provide chain operators for gate valves, butterfly valves, and plug cocks located in mechanical rooms as required by plumbing plans or where valves are mounted above 7'-0" A.F.F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install valves in each piping connection at each piece of plumbing equipment to allow equipment to be isolated from piping systems.

B. Furnish and install valves in all piping systems to isolate each floor or main section of the building. Install sufficient number of valves to minimize the portion of the system which must be shut down for service or maintenance purposes.

C. Furnish and install valves above each group of plumbing fixtures.

D. Install valves in water piping systems so ordinary maintenance work can be performed on the equipment that the valves isolate, without having to drain the system beyond the valve.

E. All valves above drywall access panels shall be located within one foot of access panels including valves located above ceilings.

F. Locate valves so as to be easily accessible by maintenance personnel.

G. Pressure reducing valves shall be installed on equipment as required per manufacturer's recommendation and on main lines serving any facility when the static pressure exceeds 80 psi as required by the State or Local Plumbing Code.

H. All plumbing systems including pumps, domestic water piping and valve settings and hot water recirculation systems must be tested and balanced. Coordinate with Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC for test and balance requirements.

END OF SECTION

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

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hangers for plumbing piping

1.2 RELATED REQUIREMENTS

A. Section 22 11 16 - Domestic Water Piping

B. Section 22 11 20 - Facility Natural Gas Piping

C. Section 22 13 16 - Storm And Sanitary Waste And Vent Piping

D. Section 22 07 00 - Plumbing Insulation

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

C. MFMA-4 - Metal Framing Standards Publication

D. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation

E. NFPA 101 - Life Safety Code

F. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.

2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with the structural requirements.

1.5 DELIVERY, STORAGE AND PROTECTION

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

1.6 SUBMITTALS

A. Submit product data and information in accordance with the provisions of Division 01.

B. Indicate where each type of hanger will be used, what piping service, if pipe system will be insulated and with what insulation thickness.

C. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports.

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

PART 2 - PRODUCTS

2.1 HANGERS

A. Acceptable Manufacturers ; Anvil, Carpenter and Patterson, Fee and Mason, B-Line, Viking, Reliable, and Michigan. Anvil model numbers are used for reference.

B. Anvil Figure #260 clevis hangers with Figure 167, MSS Type 40 galvanized insulation protection shields (sized for supporting insulation having a compressive strength of 4 psi). Support piping on outside of insulation. Size hangers so that pipe insulation passes through them without interruption.

1. All insulated piping

C. Anvil Figure CT-69, MSS Type 10 with adjustable wrought tubing ring hanger, copper plated for:

1. Non-insulated copper tubing with no longitudinal movement

2. Isolation of copper tubing from dissimilar material shall also be accomplished through the use of PHD Manufacturing, Model Numbers 2501 - 2514 Unistrut clamps with PVC inserts or PHD model number 143 PVC coated swivel ring hangers.

D. Anvil Figure #CT-121, MSS Type 8, riser clamps (at floor penetrations) to support:

1. Copper pipe risers

E. Anvil Figure #261, MSS Type 8, riser clamps (at floor slab penetrations) to support:

1. Steel pipe risers

2. PVC pipe risers

F. Anvil Powerstrut Trapeze Hangers: Where three or more lines of pipe run parallel, support them with trapeze hangers.

G. Water piping supports within walls to be by Caddy, Holdrite, Sioux Chief or approved equivalent. Support vertical drops and piping at fixture supplies in wall. Hanger material to be suitable for piping material installed. Piping supports shall be installed per manufacturer's recommendations.

2.2 METAL CHANNEL (STRUT) FRAMING SYSTEMS:

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

B. Acceptable Manufacturers: Anvil, B-Line, Unistrut, or approved equal.

C. Furnish channels and associated fittings, accessories, and hardware produced by a single manufacturer.

D. Comply with MFMA-4.

E. Material and Dimensions: Galvanized steel; 1-5/8 inch width by 1-5/8 inch height; 14 gauge minimum.

2.3 INSERTS

A. Concrete Insert: Anvil Figure #281, MSS Type 18, universal concrete inserts, adequately sized and correctly positioned to support full load operating systems.

B. Concrete Insert, Wedge Type: Anvil Figure #281, 1/4" to 7/8"

C. Lightweight Concrete Insert: Anvil Figure #285

D. Continuous Concrete Insert: Anvil Powerstrut Figure #PS-349, pre-galvanized

2.4 EXPANSION ANCHORS

A. Hilti Kwik-bolt, zinc-plated, metal expansion anchor.

B. Anchor to meet U.L., ICBO-4627 and FM listings.

2.5 HANGER RODS

A. Provide mild steel all-thread rods with maximum loads as follows:

1. 3/8" - 300 lbs
2. 1/2" - 600 lbs
3. 5/8" - 1,200 lbs
4. 3/4" - 2,000 lbs
5. 1" - 5,000 lbs

2.6 CLAMPS

A. C-Clamps: Anvil Figure #92, MSS Type 23.

1. Use these for attaching hangers to steel beams. Do not weld hanger rods to structural steel members.

B. Malleable Beam Clamps: Anvil Figure #218, MSS Type 30: Use these for attaching hangers to bar joists. Attach clamps to top chord of bar joists only. Confirm with structural engineer for maximum loading and restrictions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as required.

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

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

3.2 INSTALLATION

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

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

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

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

E. Do not penetrate or otherwise notch or cut structural members without approval of the Architect and Structural Engineer.

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

G. Equipment Support Attachment:

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

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

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

H. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

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

J. Support pipes on specified hangers so that equipment, pumps, and fittings do not bear weight or stresses from vibration and swaying of pipe. Support pipe risers at regular intervals in pipe shafts at least once at each floor level or a maximum of 12'-0" apart. Do not use perforated metal, strap iron, or band iron. Do not make offsets in hangers.

K. Maximum allowable spacing of pipe hangers is listed below. Space hangers and brackets at closer intervals where necessary to maintain levels, slopes, and drainage, or to prevent sagging or swaying of pipe.

L. STEEL PIPE - Water

1. 1/4" to 1-1/2" - 7' 0" O.C.

2. 2" to 2-1/2" - 10' 0" O.C.

3. 3" to 4" - 12' 0" O.C.

4. 5" and above - 14'0" O.C.

M. STEEL PIPE - Vapor

1. 1/4" to 1-1/2" - 8' 0" O.C.

2. 2" to 2-1/2" - 13' 0" O.C.

3. 3" and above - 15' 0" O.C.

N. COPPER PIPE - Water

1. 1/4" to 1-1/4" - 5'0" O.C.

2. 2" to 2-1/2" - 8'0" O.C.

3. 3" and above - 10'0" O.C.

O. COPPER PIPE - Vapor

1. 1/4" to 1" - 5'0" O.C.
2. 1-1/4" to 2" - 8'0" O.C.
3. 2-1/2" to 4" - 10' 0" O.C.
4. 5" and above -15' 0" O.C.

P. CAST IRON PIPE

1. Space hangers not to exceed 5 feet on centers. Provide minimum of two hangers per section within 18" of joint on barrel and at change of direction and branch connection. Install hanger and supports per CISPI 301-12.

Q. PVC PIPE

1. 3/4" to 3" - 4' O.C.
2. 4" and above - 6' O.C.

R. SWAY BRACING

1. Provide sway bracing and additional supports to meet the seismic bracing requirements.

END OF SECTION

SECTION 22 05 33
HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Self-regulating parallel resistance electric heating cable.

B. Constant wattage resistance electric heating cable.

C. Cable outer jacket markings.

D. Connection kits.

E. Accessories.

F. Controls.

G. Cables for freeze protection of plumbing piping.

H. Cables for roof and gutter deicing.

1.2 RELATED REQUIREMENTS

A. Section 22 05 53 - Identification for Plumbing Piping and Equipment

B. Section 22 07 00 - Plumbing Insulation.

C. Section 22 11 16 - Domestic Water Piping.

D. Section 22 11 19 - Domestic Water Piping Specialties.

E. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

F. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

G. Section 26 05 33.13 - Conduit for Electrical Systems.

H. Section 26 05 33.16 - Boxes for Electrical Systems.

I. Section 26 05 83 - Wiring Connections.

1.3 REFERENCE STANDARDS

A. IEEE 515.1 - IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications 2012.

B. ITS (DIR) - Directory of Listed Products current edition.

C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL (DIR) - Online Certifications Directory Current Edition.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

C. Coordinate the work with other trades to provide ground fault protection for electric heat tracing circuits as required by NFPA 70.

D. Coordinate the work with other trades to provide circuit breaker ratings suitable for installed circuit lengths.

1.5 SUBMITTALS

A. Submit product data and drawings in accordance with the requirements of Division 01.

B. Product Data: Provide data for electric heat tracing.

C. Shop Drawings: Indicate electric heat tracing layout, electrical terminations, thermostats, controls, and branch circuit connections electrical terminations, thermostats, controls, and branch circuit connections.

D. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.

E. Field Quality Control Submittals: Indicate test reports and inspection reports.

F. Project Record Documents: Record actual locations of electric heat tracing lines and thermostats.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, maintenance and repair data, and parts listings.

H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience and approved by manufacturer.

C. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide two year manufacturer warranty for cables and connection kits.

PART 2 - PRODUCTS

2.1 SELF-REGULATING PARALLEL RESISTANCE ELECTRIC HEATING CABLE

A. Acceptable Manufacturers:

1. Chromalox, Inc

2. Raychem

3. Thermon Manufacturing Company

B. Provide products listed, classified, and labeled by UL (DIR), ITS (DIR), or testing firm acceptable to authorities having jurisdiction (AHJ).

C. Factory Rating and Testing: Comply with IEEE 515.1.

D. Heating Element:

1. Provide pair of parallel No.16 tinned or nickel coated stranded copper bus wires embedded in cross linked conductive polymer core with varying heat output in response to temperature along its length.

2. Terminations: Waterproof, factory assembled, non-heating cold leads with connector at one end and water-tight seal at opposite end of sufficient length to reach junction boxes or power panel.

3. Capable of crossing over itself without overheating.

E. Insulated Jacket: HDPE or Flame retardant polyolefin.

F. Cable Cover: Provide tinned copper and polyolefin outer jacket with UV inhibitor.

G. Maximum Power-On Operating Temperature: 150 degrees F (65 degrees C).

H. Maximum Power-Off Exposure Temperature: 185 degrees F (85 degrees C).

I. See drawings for required watts/LF, voltage and circuiting.

2.2 PLASTIC INSULATED SERIES RESISTANCE ELECTRIC HEATING CABLE

A. Acceptable Manufacturers:

1. Emerson Industrial Automation; [_____]:

2. Raychem; [_____]:

B. Provide products listed, classified, and labeled by UL (DIR), ITS (DIR), or testing firm acceptable to authorities having jurisdiction (AHJ).

C. Factory Rating and Testing: Comply with IEEE 515.1.

D. Verify the operating and maximum system temperature for domestic hot water applications is compatible with the manufacturer's trace heater rating.

E. Heating Element:

1. Resistor Wire: Provide single or dual strained.

2. Terminations: Waterproof, factory assembled, non-heating leads with connectors at both ends.

F. Insulated Jacket: Minimum 4.0 mil (0.10 mm) polyimide film with silicon jacket or fluoropolymer resin.

G. Cable Cover: Provide aluminum braid and silicon or thermoplastic fluoropolymer outer jacket.

H. Maximum Operating Temperature: 300 degrees F (150 degrees C).

I. Electrical Characteristics:

2.3 CABLE OUTER JACKET MARKINGS

A. Name of manufacturer, trademark, or other recognized symbol of identification.

B. Catalog number, reference number, or model.

C. Month and year of manufacture, date coding, applicable serial number, or equivalent.

D. Agency listing or approval.

E. Applicable environmental or area use requirements, such as NEMA 4, Type 4, IP ratings, and hazardous (classified) location markings including temperature rating.

F. Any applicable warning/caution statements such as "WARNING: De-energize circuit before removing cover.

2.4 OUTDOOR ELECTRIC ROOF, GUTTER AND DOWNSPOUT DEICING

A. Acceptable Manufacturers: Danfoss; Delta-Therm Corporation; WarmlyYours Radiant Inc.

B. Provide products listed, classified and labeled by UL or ETL suitable for the purpose intended.

C. Assembly:

1. Factory designed specifically for outdoor applications.

2. Conductors: Factory insulated, copper or copper allow heating cable with standard factory coating or plating.

3. Provide factory or field spliced and sealed cold lead with single point connection of sufficient length to reach designated junction box or power panel.

D. Controls:

1. Provide manufacturer's fully automatic microprocessor based control system.

2. Sensing shall be based on moisture detection.

3. Controls to be connected to the building automation system.

E. Accessories: Roof clips, hooks, and downspout hangers. Provide system marker in accordance with NFPA 70.

2.5 CONNECTION KITS

A. Provide power connection, splice/tee, and end seal kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.

B. Provide with NEMA 4X rating for prevention of corrosion and water ingress.

C. Provide UV stabilized components.

2.6 ACCESSORIES

A. Provide accessories as indicated or as required for complete installation, including but not limited to:

1. High temperature, glass filament tape for attachment of heating cable to metal piping.

2. Aluminum self-adhesive tape for attachment of heating cable to plastic piping.

3. Heat-conductive putty.

4. Cable ties.

5. Silicone end seals and splice kits.

6. Installation clips.

7. Warning labels for attachment to exterior of piping insulation. Refer to Section 22 05 53.

2.7 CONTROLS

A. Pipe Mounted Thermostats:

1. Remote bulb unit with adjustable temperature range from 30 to 50 degrees F (minus one to 10 degrees C).

2. Snap-action, open-on-rise, single pole switch with minimum current rating adequate for the connected cable.

3. Remote bulb on capillary, resistance temperature device (RTD) or thermistor for direct sensing of pipe wall temperature.

4. Control Enclosure: Corrosion resistant and waterproof.

B. Provide minimum 30 ampere contactor to indicate operational status and on/off control.

C. Line sensing high-limit temperature control and high-limit alarm.

D. Programmable Controller:

1. Micro-processor based.

2. Capable of four separate schedules.

3. On/Off/Auto switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping and equipment are ready to receive work.

B. Verify field measurements are as indicated on shop drawings.

C. Verify required power is available, in proper location, and ready for use.

3.2 PREPARATION

A. Clean exposed surfaces prior to installation.

B. Prepare surfaces using approved methods as recommended by manufacturer.

3.3 INSTALLATION

A. Install in accordance with manufacturer's written installation instructions.

B. Comply with installation requirements of IEEE 515.1 and NFPA 70, Article 427.

C. Apply heating cable linearly on pipe with fiberglass tape only after piping has successfully completed any required pressure testing.

D. Comply with applicable local building codes and requirements of authorities having jurisdiction.

E. Grounding: Refer to Section 26 05 26.

F. Identification:

1. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft (6 m) including cladding over each valve or other equipment that may require maintenance.

2. Refer to Section 22 05 53.

G. Equipment Wiring: Refer to Section 26 05 83.

H. Electrical Connections: Refer to Section 26 05 19.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Perform start-up by factory technician or factory representative as per Owner requirements.

C. Field Testing and Inspections:

1. Commission system in accordance with installation and operation manual.

2. Inspect for sources of water entry and proper sealing.

3. Inspect weather barrier to confirm that no sharp edges are contacting the trace heating.

4. Insulation Resistance: Greater than 20 megohms at a test voltage of 2500 VDC for polymer insulated trace heaters.

5. Test heating cable integrity with megohm meter at the following intervals:

a. Before installing the cable.

b. After cable has been installed onto the piping.

c. After installing the connection kits.

d. After the installation of thermal insulation onto the piping.

e. Prior to initial start-up (commissioning).

6. Measure voltage and current at each unit.

7. Outdoor roof, gutter and downspout deicing testing:

a. Test continuity of heating cable.

b. Perform megger test (insulation resistance) on each heating cable before, during, and after installation.

c. Minimum megger reading to comply with recommendations of cable manufacturer.

d. Measure voltage and current at each unit after installation is completed.

e. Manufacturer to provide onsite cable, wiring and testing inspection.

f. Installing contractor to submit written factory wiring inspection test report indicating values measured on each test for each deicing cable to the owner.

8. Controls:

a. Verify control parameters are set to the application requirements.

b. Verify factory provided digital temperature controller is correctly configured with the building automation system.

9. Submit written test report showing values measured on each test for each cable.

3.5 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstrate operation of controls.

3.6 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe markers.

E. Ceiling tacks.

F. Installation of all tags, markers and identification for plumbing piping, medical gas piping and equipment.

1.2 RELATED REQUIREMENTS

A. Section 09 90 00 - Painting and Coating: Identification painting.

B. Section 22 07 00 - Plumbing Insulation.

C. Section 22 60 00 - Medical Gas Piping Systems: Supply of pipe labels for placement under this section.

D. Section 22 61 13 - Laboratory Gas Piping System.

1.3 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.

1.4 SUBMITTALS

A. Submit product data for review in accordance with the requirements of Division 01.

B. List: Submit list of wording, symbols, letter size, and color coding for plumbing identification.

C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

F. Project Record Documents: Record actual locations of tagged valves.

PART 2 -PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Water Heaters: Nameplates.

B. Automatic Controls: Tags. Key to control schematic.

C. Control Panels: Nameplates.

D. Instrumentation: Tags.

E. Major Control Components: Nameplates.

F. Domestic Water Piping: Pipe markers.

G. Storm, Waste and Vent Piping: Pipe Markers

H. Other Plumbing Piping: Pipe Markers

I. Pumps: Nameplates.

J. Small-sized Equipment: Tags.

K. Tanks: Nameplates.

L. Valves: Tags and ceiling tacks where located above lay-in ceiling.

M. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES

A. Acceptable Manufacturers:

1. Seton Identification Products; [_____]: www.seton.com/#sle.

2.3 TAGS

A. Acceptable Manufacturers:

1. Advanced Graphic Engraving; [_____]: www.advancedgraphicengraving.com/#sle.

2. Brady Corporation; [_____]: www.bradycorp.com/#sle.

3. Kolbi Pipe Marker Co; [_____]: www.kolbipipemarkers.com/#sle.

4. Seton Identification Products; [_____]: www.seton.com/#sle.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame. Also provide an Xcel spread sheet of all valves, with location and tag number to owner.

2.4 STENCILS

A. Acceptable Manufacturers:

1. Brady Corporation; [_____]: www.bradycorp.com/#sle.

2. Kolbi Pipe Marker Co.; [_____]: www.kolbipipemarkers.com/#sle.

3. Seton Identification Products; [_____]: www.seton.com/#sle.

B. Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch (20-30 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 1/2 inch (15 mm) high letters.

2. 1-1/2 to 2 inch (40-50 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 3/4 inch (20 mm) high letters.

3. 2-1/2 to 6 inch (65-150 mm) Outside Diameter of Insulation or Pipe: 12 inch (300 mm) long color field, 1-1/4 inch (30 mm) high letters.

4. 8 to 10 inch (200-250 mm) Outside Diameter of Insulation or Pipe: 24 inch (600 mm) long color field, 2-1/2 inch (65 mm) high letters.

5. Over 10 inch (250 mm) Outside Diameter of Insulation or Pipe: 32 inch (800 mm) long color field, 3-1/2 inch (90 mm) high letters.

6. Equipment: 2-1/2 inch (65 mm) high letters.

C. Stencil Paint: As specified in Section 09 91 23, semi-gloss enamel, colors complying with ASME A13.1.

2.5 PIPE MARKERS

A. Acceptable Manufacturers:

1. Brady Corporation; [_____]: www.bradycorp.com/#sle.

2. Kolbi Pipe Marker Co; [_____]: www.kolbipipemarkers.com/#sle.

3. Seton Identification Products; [_____]: www.seton.com/#sle.

B. Colors and lettering: Comply with ASME A13.1.

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

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

E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

F. Color code as follows:

1. Potable hot and cold water, Other make-up Water: Green with white letters.

2. Storm water: Green with white letters.

3. Sanitary waste and vent: Green with white letters.

4. Flammable Fluids: Yellow with black letters.

2.6 CEILING TACKS

A. Acceptable Manufacturers:

1. Craftmark Pipe Markers; [_____]: www.craftmarkid.com/#sle.

B. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

C. Color code as follows:

1. Plumbing Equipment: Yellow.

2. Plumbing Valves: Green.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

B. Piping requiring insulation shall be insulated prior to pipe identification being installed.

3.2 INSTALLATION

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

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09 91 23.

D. Install plastic pipe markers in accordance with manufacturer's instructions. Install markers at least once in every room and at no more than 20 foot intervals.

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

F. Label piping within each mechanical room, Water Entry

G. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

H. Use tags or pipe markers on piping 3/4 inch (20 mm) diameter and smaller.

1. Identify service, flow direction, and pressure.

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

3. Locate identification not to exceed 20 feet (6 m) on straight runs, at least once in every room and including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

I. Install equipment with plastic nameplates.

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

END OF SECTION

SECTION 22 07 00
PLUMBING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Insulation of plumbing piping

B. Insulation of plumbing equipment

1.2 RELATED REQUIREMENTS

A. Section 23 07 00 - HVAC INSULATION

1.3 DEFINITIONS

A. Exposed - Equipment and piping in areas which will be visible without removing ceilings or opening access panels.

B. Concealed - Installed above ceiling, in walls or chases.

C. Outdoors - Exposed to the weather or ambient conditions.

D. Underground - Buried.

1.4 SUBMITTALS

A. Submit manufacturer's product data and installation procedures for review in accordance with the requirements of Division 01.

1.5 QUALITY ASSURANCE

A. Insulation, adhesives, coatings, sealers, jackets and tapes shall have a flame spread rating of 25 or less and smoke development of 50 or less in accordance with ASTM E-84 and UL 723.

B. Materials shall meet the requirements of NFPA 90A.

C. Manufacturer qualifications: ISO 9001-2000 Certified specializing in manufacturing the products specified in this section.

D. Applicator qualifications: Company specializing in the installation of the specified products and the work required to install the products with not less than 5 years experience.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

A. Materials for Pipe and Equipment: Provide factory premolded insulation for pipe, pipe fittings, and valves.

B. Fitting insulation: Same thickness and material as adjoining pipe insulation.

C. Flexible Tubular Elastomeric:

1. Provide fire-retardant closed-cell slip-on flexible type; with a "K" value of 0.245 BTU-in/hr-ft2-degree F at 75 degrees F.

2. Acceptable manufacturers: Armacell AP Armaflex; K-Flex USA Insul-Tube; Aeroflex Aerocell.

3. Use on the following services:

a. Moisture condensate drains - 1/2" thick

b. Drain bodies, traps and horizontal drain lines receiving cold condensate - 1/2" thick

D. Fiberglass Pipe Insulation:

1. Acceptable manufacturers: Johns-Manville "Micro-Lok HP"; CertainTeed; Knauf; Owens Corning, Foster. Jacket: ASJ fiberglass reinforced Kraft paper with aluminum foil; minimum R value of 3.7 per inch of thickness.

2. Use on the following services:

a. Domestic hot water supply piping (105 to 140 degrees F) - 1-1/4" and smaller--1" thick; 1-1/2" and larger--1-1/2" thick.

b. Domestic hot water recirculation piping - 1" thick up to 1-1/4" pipe size; 1-1/2" thick on pipe sizes 1-1/2" and larger; 1-1/2" thick on 140 degree F systems up to 1-1/4" pipe size and 2" thick on piping 1-1/2" and larger.

c. Domestic cold water piping indoors - 1/2" thick.

d. Domestic water piping in exterior walls - 1" thick.

e. Horizontal rain water leaders and roof drain bodies - 1" thick.

f. Drain bodies, traps and horizontal drain lines receiving cold condensate - 1" thick

g. Heat traced outdoor domestic water piping - 2" thick.

E. Fiberglass Equipment insulation:

1. Acceptable Manufacturers: Johns-Manville; Certainteed; Knauf; Owens Corning, Foster.

2. Apply to equipment as directed by the manufacturer.

3. Provide vapor barrier as required when the liquid temperature is below 65 degrees F.

2.2 MATERIALS FOR FITTINGS, VALVES, AND SPECIAL COVERINGS

A. For all services, use premolded insulation for pipe fittings, elbows, tees, butterfly valves, and couplings 2-1/2 and larger. Finish shall be as specified under Products above or as specified below. PVC fitting covers with full thickness fiberglass inserts may be used on piping fittings elbows and valves 2" and less for the following services:

1. Domestic Cold Water

2. Domestic Hot Water

3. Domestic Hot Water Recirc.

B. For piping installed above grade exposed-to-the-weather outside the building, cover straight pipe insulation with 0.016" thick aluminum jacket equivalent to Childers and cover fittings with factory formed covers equivalent to Elljacs.

C. Elastomeric adhesives and finishing:

1. Adhesive shall be the insulation manufacturer's recommended contact adhesive, Armaflex 520, Armaflex 520BLV or equivalent.

2. Insulation finish shall be the insulation manufacturer's recommended finish--WB Armaflex finish and shall be paintable.

3. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and not detract from any of the system ratings as specified.

4. Where exposed to view inside buildings, the painted finish color shall be as selected by the Architect.

2.3 JACKETS

A. Canvas Jacket: UL listed 6oz/sq. yd. plain weave cotton fabric treated with dilute fire retardant lagging adhesive compatible with insulation.

B. Aluminum Jacket: ASTM B209 formed aluminum sheet of 0.016 inch, smooth finish with longitudinal slip joints and 2" laps, 0.016" thick die shaped fittings with factory attached protective liner. Adhere with 3/8" wide aluminum bands.

C. PVC Jacket: One piece molded type fitting covers and sheet material, off-white in color, 15 mil thickness, 0.002 perm inch maximum in accordance with ASTM E96. Adhere with pressure sensitive color matching vinyl tape.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Deliver and store insulation materials in manufacturer's containers and keep free from dirt, water, chemical and mechanical damage.

B. Complete piping pressure testing prior to applying insulation.

C. Apply insulation in workmanlike manner by experienced and qualified workmen.

D. Surfaces shall be clean and dry when covering is applied. Covering to be dry when installed and before and during application of any finish, unless such finish requires specifically a wetted surface for application.

E. Adhesives, cements and mastics shall be compatible with materials applied and shall not attack materials in either wet or dry state..

3.2 INSTALLATION OF PIPE COVERING

A. Where glass fiber or flexible tubular elastomeric insulation is used on piping sized 2" and larger, insert a section of foamglass or calcium silicate insulation, at hanger or support points, between pipe and metal shield for full length of shield, to prevent crushing of insulation. Where insulation passes through pipe hangers and across trapeze supports, 12" long metal saddles shall be used. Insulation thickness to be same as adjoining glass fiber insulation. On cold pipe, vapor barrier should be carried through the hanger and sealed. Saddles shall be used where rigid foamglass inserts are not acceptable.

B. Pipe exposed in mechanical equipment rooms within 8 feet of the finished floor: Finish with canvas jacket ready for finish painting.

C. Storm and overflow drain piping shall be insulated from the drain bodies to the horizontal and down through the first 3 feet of the vertical piping. Storm and overflow drain piping shall be insulated on any and all horizontal piping as it occurs due to offsets and changes in direction within the building.

D. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints and valves with insulation of like material and thickness as adjoining pipe and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

E. Install equipment insulation in accordance with manufacturer's requirements and OSHA requirements.

F. Apply foamglass insulation as follows:

1. Both the circumferential and longitudinal joints shall be buttered with fire-resistive pliable sealer. Voids and cracks shall be filled with sealer. Apply appropriate mastic as specified under Part 2 - Products. Secure insulation with 3/4" wide x 0.010" thick aluminum bands on 8" centers.

2. The circumferential joints shall be staggered.

3. Fittings, valves, flanges, traps, and air vents shall be insulated with the same thickness of insulation using factory fabricated fitting sections or pre-molded insulated fittings.

4. Block type insulation shall be adhered by stick-clips or bands, in addition to the sealer, as required to provide support for the insulation.

5. Finish above furred ceilings and in chases shall be the bare insulation.

6. Finish in equipment rooms and elsewhere where exposed-to-view shall be White ASJ jacket.

7. Finish on underground insulation shall be Pittsburgh Corning Pittwrap as recommended by manufacturer.

G. Finish on all piping exposed-to-the-weather shall be 0.016 inch thick, Childers, or equal, aluminum jacket on lines and Elljacs, or equal, pre-formed aluminum covering on fittings.

END OF SECTION

SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping and pipe fittings for domestic cold, hot and recirculating water piping.

1.2 RELATED REQUIREMENTS

A. Section 22 05 00 - Common Work Results For Plumbing

B. Section 22 05 53 - Identification for Plumbing Piping and Equipment

C. Section 22 11 19 - Domestic Water Piping Specialties

1.3 SUBMITTALS

A. Submit product data for review on piping and fittings in accordance with the requirements of Division 01. Submittal data shall include:

1. Manufacturer of pipe.

2. Tests or listings by recognized testing laboratory that certifies material composition is in accordance with ANSI/ASTM requirements.

3. Product data for pipe and fittings to be used on each piping system.

4. Solder and brazing product data and installation procedures for copper pipe.

5. Pressed pipe and fitting installation methods and instructions for copper pipe.

1.4 QUALITY ASSURANCE

A. Lead Free: All wetted surface of pipe, fittings and fixtures in potable water systems shall have a weighted average lead content equal to or less than 0.25% per the Safe Drinking Water Act (Section 1417) as amended January 4, 2011.

B. NSF Compliance: NSF/ANSI 61, NSF 61-G and/or NSF/ANSI 372 for valve materials for potable-water service. Valves for domestic water must be 3rd Party Certified.

C. Identify pipe with marking including size, ASTM material classification and specification and water pressure rating.

D. Compliance with ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

E. Compliance with ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

F. Compliance with ASME B16.51 - Copper and Copper Press-Connect Pressure Fittings.

1.5 DELIVERY, STORAGE AND HANDLING

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

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

1.6 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED BEYOND 5 FEET (1500 MM) OF BUILDING

A. Ductile Iron Pipe: AWWA C151/A21.51.

1. Fittings: AWWA C110/A21.10, ductile or gray iron, standard thickness.

2. Joints: AWWA C111/A21.11, styrene-butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch (19 mm) diameter rods.

3. Use Class 52 thickness or heavier for 12" diameter and less and Class 51 thickness or heavier for 14" diameter and larger.

4. Furnish pipe with standard thickness cement lining on inside with a bituminous seal coat and a bituminous coating on the outside.

5. Clearly mark pipe exterior to indicate the manufacturer, date of manufacturer, pipe class and weight.

6. Fittings:

a. Acceptable Manufacturers: Fastite by Acipco, Tyton by U.S. Pipe Co., or equal.

b. Ductile iron, cement lined, bituminous coated, manufactured in accordance with the latest revision of ANSI/AWWA C110

c. Furnish with mechanical joints conforming to ANSI A21.11 with 250 psi pressure rating

B. Copper Pipe: ASTM B42, hard drawn.

1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

2. Joints: ASTM B32, alloy Sn95 solder.

3. Joints: AWS A5.8M/A5.8, BCuP copper/silver braze.

C. PVC Pipe: AWWA C900.

2.2 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Copper Pipe: ASTM B42, hard drawn.

1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

2. Joints: ASTM B32, alloy Sn95 solder.

3. Joints: AWS A5.8M/A5.8, BCuP copper/silver braze.

B. Copper Pipe: ASTM B42, annealed.

1. Fittings: ASME B16.26, cast bronze.

2. Joints: Flared.

DOMESTIC WATER PIPING, ABOVE GRADE

C. COPPER PIPE, FITTINGS AND JOINTS

1. PIPE: Conform to ASTM B-88 specification for wrought seamless copper.

a. Type L, hard for:

1) Domestic cold water piping

2) Domestic hot water

3) Domestic hot water recirculating piping

b. Use Type K, rolled, soft for: Piping installed under floor slabs.

2. COPPER PIPE FITTINGS AND COUPLINGS

a. Sweat type, wrought copper Fittings, ASTM B62, with dimensions conforming to ANSI B16.22 and sweep patterns for copper tubing.

b. Grooved-End Copper Fittings: Fittings shall be manufactured to copper tubing sizes, with grooves designed to accept grooved end couplings of the same manufacturer. Fittings shall be wrought copper, conforming to ASTM B-75 alloy C12200 or ASTM B-152 alloy C11000 and ANSI B16.22, or bronze sand casting ANSI B16.18 and UNS-C89836. Victaulic or Gruvlok Copper Connection Fittings.

1) Pressed Copper Fittings: Wrought copper, ASTM B88, conforming to ASME B16.51, NSF 61 and NSF 61-G and/or NSF 372 with dimensions conforming to ANSI B16.22 or B16.18. Pressed copper fittings 1/2" through 4" shall be suitable for use with ASTM B88 copper tube Type K, L, or M and 1/2" up to and including 1-1/4" annealed copper tube. Pressed copper fittings shall have an EPDM sealing element conforming to IAPMO PS 117 performance criteria and shall have a Smart Connect feature. Sizes 2-1/2" through 4"

shall have a 420 stainless steel grip ring, PBT separator ring, EPDM sealing element and Smart Connect feature. Viega Pro-press or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Clean inside of pipe before installation. Keep installed piping clean, and protect ends from foreign matter by capping or plugging them.

C.

D. Install pipe so that it does not interfere with opening of doors or apparatus, access to equipment, or to electrical equipment.

E. Do not install pipes in such a way that they will apply torque to pumps. After pumps have been installed and pumps have been operated, recheck and realign pumps if necessary.

F. Run pipes in straight lines and square with building. Install risers plumb. Make offsets only where indicated and where necessary.

G. Install branch connections using separate tee or lateral fittings for each branch. Do not combine branches into "bullhead tee" arrangement.

H. Do not install water pipes in electric rooms, tele/data rooms, transformer rooms, audio/visual rooms or elevator equipment rooms. Fire protection piping runouts serving only these rooms shall be installed in these rooms.

I. Do not install piping above electrical equipment such as starters, panels, variable frequency motor controllers, motor control centers, or disconnects. Maintain code required clearance above, below and to sides of electrical equipment.

J. Provide flanges or unions throughout the pipe systems at all equipment. Make provisions for servicing and removal of equipment without dismantling piping.

K. Piping Expansion:

1. Install piping to allow thermal expansion and contraction without injury to piping, equipment or structure.

a. Use loops or expansion joints where necessary and where detailed. See Section 22 05 48.

b. Provide pipe guides

L. Branch Lines:

1. Where possible branch lines shall come off top of mains to prevent sediment, welding slag, or pipe deburrs from entering the branch lines and causing valve leakage or failure.

M. Identify piping and systems in accordance with Section 22 05 53.

3.2 PIPE JOINTING

A. Preparing Pipe Ends:

1. Machine cut pipe ends square

2. Ream pipe ends, after cutting, to full diameter

B. Grooved Coupling Installation:

1. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.

2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.

3. All grooved components (couplings, fittings, valves, gaskets, bolts and nuts) shall be of one manufacturer.

C. Soldered and Brazed Joints:

1. Make Type L copper pipe joints with suitable flux and 95/5, lead free solder.

2. Make Type K copper pipe joints with silver (BAg series) brazing filler material with flux or copper-phos (BCuP series) brazing filler material without flux per the recommendations of the Copper Development Association.

3. Domestic cold and hot water piping 4" and larger shall be brazed. Copper to copper joints shall be brazed using a copper-phosphorus or copper-phosphorus-silver brazing filler metal (BCuP Series) without flux. Dissimilar metals such as copper and bronze or brass shall be brazed using an appropriate flux with a silver (BAg Series) brazing filler metal.

a. In lieu of brazing, domestic cold and hot water piping 4" and larger may be joined with rolled grooved copper fittings and valves by Victaulic or Anvil, copper pipe grooved systems.

D. Pressed Copper Fittings:

1. Press copper fittings shall be made in accordance with the manufacturer's most current installation instructions. Tube ends shall be cut on a right angle (square) to the tube. Tube ends shall be reamed and chamfered; all grease, oil and dirt removed from the tube end with a clean rag. The tubing shall be fully examined to ensure there is no damage. Fully insert the tube into the fitting and mark the tubing at the shoulder of

the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting prior to pressing the joint. The joints shall be pressed using Rigid Pressed Copper tools or other tool(s) approved by the manufacturer. Fitting shall have a 5 year warranty that the system shall be free of failure from manufacturing defects.

2. Installers shall attend a Pressed Copper installation training class from the manufacturer prior to any installation. Records of the installers training shall be maintained at the job site.

3. For sizes 2-1/2" to 4", the installer shall ensure that the stainless steel grip ring is in place.

3.3 ESCUTCHEONS

A. Provide chrome plated escutcheons where uninsulated pipes penetrate walls or ceilings of finished spaces.

3.4 STRAINERS

A. Install strainers so the strainer basket can be removed without spilling water on motors and electrical equipment.

3.5 AIR VENTING

A. Provide manually operated air vents at high points in vertical risers to eliminate air from systems.

B. Use ball valves for manual air vents.

3.6 VALVE ACCESS

A. Locate ceiling/wall access panels at shut-off and control valves for proper access and operation. Furnish and install access doors in accordance with Section 22 05 00 and other Divisions as applicable.

3.7 TESTING

A. Before piping is concealed or insulated, recheck it for leaks.

B. Rework or replace defective and leaking joints, and joints which are otherwise unsatisfactory. Peening, caulking, and doping are not permitted.

C. After Pressed Copper fittings have been installed, a "step test" shall be followed:

1. Pressurize the system with air or dry nitrogen between 0.5psig and 45psig, or with water between 15psig and 85psig for a minimum of 4 hours.

2. Check the pressure gauge for pressure loss. If the system does not hold pressure, walk the system and check for un-pressed fittings.

3. When un-pressed fittings are found, ensure the tube is fully inserted into the fitting and the tube is properly marked prior to pressing the fitting.

4. Make appropriate repairs and retest the system per local code and these specifications.

END OF SECTION

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes requirements for:

1. Backflow preventers.
2. Shock arrestors.
3. Inline automatic flow controller.
4. Thermometers and pressure gauges.
5. Domestic Water expansion tank
6. Thermostatic balance valve

1.2 RELATED REQUIREMENTS

A. Section 22 05 00 - Common Work Results For Plumbing

B. Section 22 05 23 - Valves For Plumbing Piping

C. Section 22 07 00 - Plumbing Insulation

1.3 QUALITY ASSURANCE

A. Lead Free: All wetted surface of pipe, fittings and fixtures in potable water systems shall have a weighted average lead content equal to or less than 0.25% per the Safe Drinking Water Act (Section 1417) as amended January 4, 2011.

B. NSF Compliance: NSF/ANSI 61 and/or NSF/ANSI 372 for valve materials for potable-water service. Valves for domestic water must be 3rd Party Certified.

1.4 SUBMITTALS

A. Submit product data for review in accordance with the requirements of Division 01.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are indicated in subsequent paragraphs.

2.2 BACKFLOW PREVENTERS

A. Acceptable manufacturers:

1. Beeco
2. Apollo
3. Febco
4. Cla-Val
5. Ames
6. Watts
7. Wilkins Regulator Company

B. Provide completely automatic unit, fitted with tight closing shut-off valves and test cocks at each end.

C. Construct such that all parts are replaceable without removing unit from line.

D. Total pressure drop through complete backflow preventer does not exceed 12 PSI at rated flow.

E. Provide per local requirements and dimensions as detailed on drawings.

F. Backflow preventers shall meet the following standards: (Apollo Figure numbers are used for reference.)

1. Atmospheric vacuum breaker - Apollo 38-200 series, ASSE 1001-2017
2. Hose-connected vacuum breakers - Apollo 38-414, ASSE 1011-2017
3. Back siphonage vacuum breakers - Apollo 4A-500-04F, ASSE 1056-2013
4. Reduced pressure principle backflow preventers - Apollo 4ALF-200 Series, ASSE 1013-2011
5. Double check valve assembly - Apollo 4ALF-100 Series, ASSE 1015-2011
6. Pressure type vacuum breaker - ASSE-1020-2020

2.3 SHOCK ARRESTORS

A. Acceptable manufacturers:

1. Josam
2. Wade
3. Jay R. Smith
4. Precision Products

5. Zurn

6. Sioux Chief

B. Arrestor shall be piston type, polycarbonate with two EPDM O-rings, lubricated with FDA-approved Dow Corning #111 silicone compound in Type L or K copper body, suitable for 200 psig minimum pressure at 200 degrees F.

C. Arrestor shall be ANSI/ASSE 1010 Certified and be maintenance free with no access panel required.

2.4 THERMOMETERS AND PRESSURE GAUGES

A. Acceptable manufacturers: Trerice, Winters, Dwyer or approved equal.

B. Thermometers shall have a 9" aluminum case with 3.5" or 6" stem, fully adjustable, organic filled (non-mercury), +/- 1% accuracy, lead free brass or stainless steel thermowell, dual scale, 30 degrees F to 200 degrees F range.

C. Pressure gauges shall have a 4" white aluminum dial with type 304 SS case, lead free brass socket, glycerin filled with accuracy of +/- 1.5 % of full scale to 150 degrees F; dry type to 200 degrees F. Install with lead free gauge cock.

2.5 MANUAL FLOW BALANCING VALVE

A. Acceptable Manufacturers: Nibco, Armstrong 'CBV'; Taco; Tour & Andersson.

B. Provide globe style valve, calibrated, lead free, brass or stainless steel body and disk, with provisions for connecting a portable differential pressure meter for flow measurement and balance. Nibco T-1810-LF or S-1810-LF or equal. Provide meter connections with built-in check valves.

C. Provide integral pointer to register degree of valve opening with tamper proof locking memory feature.

D. Provide valve with drain connection.

E. Construct valve with integral sleeves to prevent leakage around rotating element.

F. Construct valve for 125 psi working pressure at 260 degrees F.

G. Provide preformed polyurethane insulation for easy access to valve without disturbing field applied adjacent insulation.

H. Provide valve with engraved tag attached indicating design flow, pressure, and flow characteristic of station.

2.6 DOMESTIC WATER EXPANSION TANK

A. Acceptable Manufacturers:

1. Amtrol Inc. - THERM-X-TROL
2. Bell and Gossett Series PT
3. Taco PAX Series
4. Watts PLT Series

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1; rated for working pressure of 150 psig at 200 degrees F; stainless steel connectors; polypropylene liner; flexible FDA approved butyl/EPDM diaphragm or butyl bladder sealed into the tank; with steel legs, stand or saddles. Tank shall meet the requirements of NSF 61 for Lead Free construction and use. Designed for use in potable water systems.

C. Accessories: Pressure gauge, air charging fitting and tank drain fitting. Precharge to 40 psig.

D. Capacity: As noted on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION AND TESTING

A. Backflow Preventers:

1. Pipe relief through fixed air gap and discharge to sewer.
2. Install adjacent to wall and/or floor utilizing stand-off brackets, angle frame, and/or concrete piers.
3. Test unit for leaks and pressure drop. Clean and/or replace soiled strainer media.
4. Provide dual parallel reduced pressure backflow preventers on the main domestic water entrance to the facility.
5. Provide a reduced pressure backflow preventer on the domestic hot and cold water lines feeding the laboratory and morgue.
6. Provide a reduced pressure backflow preventer on the domestic cold water serving carbonators at soda machines.
7. Provide backflow prevention vacuum breaker on any water line feeding any piece of equipment which could cause back siphonage such as mechanical equipment, trap primer lines, etc.
8. Provide a double check valve backflow preventer on the fire main service to the building.

B. Shock Arrestors:

1. Install shock arrestors at each quick closing valve, solenoid type valve, and flush valve. Size shock arrestors in accordance with manufacturer's instructions.

2. Install shock arrestors within five feet of valve, provide wall access panel as required.

3. Test and certify shock arrestors by Plumbing and Drainage Institute in accordance with ANSI/ASSE 1010.

C. Expansion tanks:

1. Install in locations shown on the drawings and in accordance with the details and manufacturer's requirements.

END OF SECTION

SECTION 22 11 20
FACILITY NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Natural gas piping

B. Natural gas valves

C. Natural gas pressure regulators

1.2 RELATED REQUIREMENTS

A. Section 22 05 00 - Common Work Results for Plumbing

B. Section 22 05 29 - Hangers for Plumbing Piping

1.3 REFERENCE STANDARDS

A. ASME B31.2 - Fuel Gas Piping; The American Society of Mechanical Engineers; 1968.

B. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2011 (ANSI/ASME B31.9).

C. NFPA 54 / ANSI Z223.1 - National Fuel Gas Code; National Fire Protection Association; 2015.

1.4 SUBMITTALS

A. Submit product data for review in accordance with the provisions of Division 01 for piping, fittings, valves, and coatings. Submittal data shall include but not be limited to:

1. Manufacturer of pipe.

2. Tests or listing by recognized testing laboratory that certifies material composition is in accordance with ANSI/ASTM requirements.

3. Product data for piping, fittings, valves and coatings.

4. Welding procedures for steel pipe.

5. Heat fusion jointing methods.

1.5 QUALITY ASSURANCE

A. Material standards: Applicable ASTM standards for material requirements.

B. Dimensional standard: ANSI B36.10, latest edition.

C. Screw threads: American Pipe Thread Standards.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Pipe: Schedule 40 black steel ASTM A 53 seamless or continuous weld.

1. Use exposed above ground or within buildings.

2. Use underground with exterior coating as specified herein.

B. Medium-Density Polyethylene (MDPE) Yellow Gas Pipe

1. Acceptable manufacturer: JM Eagle or equal.

2. Sizes: 1/2" through 12"

3. Compliance: meets ASTM D2513, Standard for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.

4. Jointing method: Heat fusion jointing by socket fusion or butt fusion.

5. Weather resistance: Provide pipe with UV stabilizer to protect from UV degradation when exposed to direct sunlight for a minimum of 3 years.

6. Use for underground natural gas service only.

C. Fittings:

1. Welded fittings: Factory made fittings, full line size for all branches, elbow, or tee. Use reducers after fittings if dictated by branch pipe size.

2. Screw fittings: Grinnell or approved equal, Class 150, malleable iron.

a. Joint compound: LACO, Rector-Seal, or WKM Key-Tite.

3. Press Fittings: Viega MegaPress G Black steel Press-Connect or equal mechanical joint fittings for black steel pipe

a. Sizes: 1/2" to 2", listed to ANSI LC-4

b. Operating Pressure: 125 psi maximum

c. Operating Temperature: 0 degrees F to 180 degrees F

d. Sealing Element: HNBR

e. Leakage Path Connection Feature: Provide factory design of leakage path for unpressed fittings and Color-coded markings on exterior of fitting for readily identifying/inspecting sealing element type.

f. Installation: Install in accordance with the manufacturer's written instructions using only tools approved by the fitting manufacturer.

D. Valves:

1. 2" and smaller: AGA or UL approved

2. 2-1/2" and larger: Certified by the manufacturer for natural gas service

3. Provide valves with handle

4. Valves shall be acceptable to local authorities

E. Exterior coating: Republic Steel Corporation's X-Tru-Coat high density polyethylene extruded coating.

F. Lubricated Plug Cocks:

1. For valves 2" and less, iron body, threaded, Nordstrom Figure No. 114.

2. For valves 2-1/2" to 4", iron body, flanged, Class 125, Nordstrom Figure No. 115.

3. For valves 5" and up, iron body, flanged, worm gear operated, 200 CWP, Class 125, Nordstrom Figure No. 169.

4. Provide visual position indicators on all plug cocks.

5. All valves shall be AGA approved for natural gas service.

G. Valve Connections: Two inches and smaller - threaded; 2-1/2 inches and larger - flanged.

H. Strainers:

1. Acceptable Manufacturers: Armstrong International; Green Country Filter Manufacturing; WEAMCO.

2. Sizes 2" and smaller: Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

3. Sizes 2-1/2" and larger: Class 125, flanged iron body, basket pattern with 1/8 inch stainless steel perforated screen.

I. Gas Pressure Regulator Valves:

1. Gas pressure regulator valves shall meet ANSI Z21.80a, CSA 6.22a-2005 as manufactured by Pietro Fiorentini, Fisher, Maxitrol, or approved equal.

2. Gas regulators for use in systems at 5 psi and 2 psi shall be provided with an AGA approved automatic vent limiting device for indoor use only.

3. All pressure regulators installed in systems that operate above 5 psi shall have a vent piped in accordance with Government and local codes and regulations to the exterior of the building. Provide vent protectors for outdoor applications to protect vents from foreign particles, insects, dust, rain or snow.

4. See drawings, installation section and schedules for location and sizes of gas pressure regulator valves and vent routing.

J. Roof Top Support Mounting Blocks:

1. Roof top supports for mounting natural gas piping by B-Line, Durablok, Miro, or Roof Top Blox. Wood blocking shall not be used. Material to be UV and weather resistant

2. Connect piping to support blocking or stands per manufacturers specifications and spacing requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Jointing: All welded construction, except where required for servicing and for sizes 4" and smaller as specified herein.

B. Screwed fittings:

1. May be used in lieu of welded joints for sizes 4" and smaller when pressure is 5 psi or less.

2. Install screwed joints to be accessible for repair.

3. Do not install screwed fittings in furred ceilings or chases.

C. Provide a gas valve at each piece of equipment and where indicated and where indicated on drawings.

D. Pipe vents from each natural gas pressure regulator independently to the exterior of the building. Vent sizes shall be connection size and as recommended by the regulator and equipment manufacturer.

E. Underground gas piping shall be of the same metals and meet the same working pressure requirements specified herein, except that it shall be coated and protected as follows:

1. Coat exterior surface of underground gas pipe with high density polyethylene extruded coating.

2. The protective coating shall be factory applied with a fluid mastic undercoat. The polyethylene coating shall be minimum of 0.040 inches thick.

3. Field welds, joints and fittings shall be protected with mastic undercoat and by wrapping with at least two (2) layers (half lap) of “X-Tru-Tape” installed as

recommended by the manufacturer or with Raychem "Thermofit" heat shrinkable pipe sleeves applied as recommended by the manufacturer.

F. Cathodic Protection: All underground steel and steel tubing gas piping shall be provided with a cathodic protection system per NFPA 54; Chapter 7.1.3, Corrosion Protection of Piping.

G. Concealed piping: Where indicated on drawings or when required by local code authorities, provide an A-53 Schedule 10 black steel pipe sleeve to completely enclose the gas pipe through all chases and concealed areas of the building . Vent sleeve to atmosphere at the top of the building.

H. Underground piping: Before backfilling, electrically test all underground piping, fittings, joints and valves for location of possible defects in the protective coating. Cover breaks in the coating with The Tapecoat Company, Inc., "Tapecoat SP" or equal. Apply Tapecoat in accordance with manufacturer's instructions.

I. Underground MDPE piping shall be properly and continuously bedded and installed in accordance with the manufacturer's written installation instructions. Piping shall be allowed to contract while cooling prior to backfill.

1. Provide pipe locater tracer wire a minimum of 12" above the piping during backfill so pipe can be properly located after installation.

2. All piping and joints shall be tested for a leak free installation prior to covering or backfill.

END OF SECTION

SECTION 22 11 23
DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Hot Water Recirculation Pumps

1.2 RELATED REQUIREMENTS

A. Section 22 11 16 - Domestic Water Piping

B. Section 22 05 23 - Valves For Plumbing Piping

C. Section 22 05 53 - Identification for Plumbing Piping and Equipment

D. Section 26 29 23 - Variable Frequency Motor Controllers

E. Division 26: Electrical

1.3 SUBMITTALS

A. Submit certified product data for review in accordance with the requirements of Division 01.

B. Submit certified pump curves showing operating points, capacity, wiring diagrams and operating instructions. Include NPSH curves and operating sequences when applicable.

1.4 QUALITY ASSURANCE

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

B. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of mid-point of published maximum efficiency curve.

C. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this sections with a minimum of 5 years experience.

D. Pumps shall meet all ASHRAE 90.1 requirements and have programmed logic to reduce flow based on system pressure sensors to reduce pump speed and flow during periods of minimum use.

E. Pumps and control systems shall have control logic to shut pumps off during periods of no flow or use and be able to restart when flow is needed to maintain minimum pressure in accordance with the requirements of ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 VARIABLE SPEED RECIRCULATING PUMP

A. Acceptable manufacturers: Bell & Gossett ECOCirc XL, Grundfos

B. Construction: Cast iron or lead free bronze, flanged connections, 175 psig, 230 degrees F, high efficiency, variable speed, wet rotor pump with integrated drive.

C. Controls: Proportional pressure, constant pressure, constant speed, auto-night mode, 0-10V analog input, 4-20mA pressure sensor, external start/stop, BACnet communication to BAS and PC/laptop, temperature sensor control.

D. Display: operating status, warning and alarms, errors and work log history, dry run detection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify location and clearance requirements.

B. Install in accordance with manufacturer's recommendations and as shown and detailed on the drawings.

3.2 START-UP AND TEST

A. Start-up pump, verify integrity of connection and electrical phasing.

B. Test and balance pumps in operation under design load conditions.

C. Coordinate with Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC for test and balance requirements.

D. Test pumps and system controls to meet ASHRAE 90.1 requirements.

END OF SECTION

SECTION 22 13 16
STORM AND SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Sanitary waste and vent piping

B. Storm water piping

C. Rooftop AC unit condensate drain piping

1.2 RELATED REQUIREMENTS

A. Section 22 05 00 - Common Work Results For Plumbing

B. Section 22 05 29 - Hangers for Plumbing Piping

C. Section 22 13 19 - Sanitary Waste Piping Specialties

1.3 REFERENCE STANDARDS

A. ASTM F1673 - Standard specification for Polyvinylidene Fluoride (PVDF) Corrosive Drainage Systems

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

C. ASTM D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

D. ASTM D 2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems

E. ASTM E2567 - Standard Test Method for Determining Nodularity and Nodule Count in Ductile Iron Using Image Analysis

F. ASTM D 2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

G. ASTM F667/667M - Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings

H. ASTM F2618 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Fittings for Chemical Waste Drainage Systems

I. ASTM C 1540 - Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings

J. ASTM D 2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings

K. ASTM D 3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

L. ASTM F 481 - Standard Practice for Installation of Thermoplastic Pipe and Corrugated Pipe in Septic Tank Leach Fields

M. ASTM F 493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

N. ASTM A-74 - Standard Specification for Cast Iron Soil Pipe and Fittings

O. ASTM A-888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

P. AWWA C151 - Ductile Iron Pipe, Centrifugally Cast, for Water

Q. AWWA C110 - Ductile-Iron and Gray-Iron Fittings

R. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary

S. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.

T. UL 723 - Tests for Surface Burning Characteristics of Building Materials

1.4 SUBMITTALS

A. Submit product data for review on piping and fittings in accordance with the requirements of Division 01. Submittal data shall include:

1. Manufacturer of pipe.

2. Tests or listing by recognized testing laboratory that certifies material composition is in accordance with ANSI/ASTM requirements.

3. Product data for pipe and fittings to be used on each piping system.

4. Identification of where each pipe type will be used.

1.5 QUALITY ASSURANCE

A. Identify pipe with marking including size, ASTM material classification and ASTM specification.

1.6 DELIVERY, STORAGE AND PROTECTION

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

PART 2 - PRODUCTS

2.1 CAST IRON PIPE AND FITTINGS

A. Conform to ASTM A-74 ASTM A-888; and CISPI 301-12 and CISPI 310-12.

B. Pipe and fittings shall be marked with the collective trademark of Cast Iron Soil Pipe Institute and be listed by NSF International.

C. Standard weight pipe with drainage fittings for:

1. Sanitary waste, vent, and drainage pipe 2" and larger above ground.

2. Building storm drains.

3. Rainwater conductors inside building.

4. Drain lines under buildings, and under exterior concrete or other paving. Extend cast iron piping at least 5 feet outside of building.

D. Joints in Cast Iron Pipe:

1. Below grade: Bell and spigot with neoprene compression gaskets

2. Above grade: No-Hub using stainless couplings. Provide 4-band, heavy duty couplings for piping 2" through 10" and 6-band heavy duty couplings for piping 12" and larger. Couplings shall comply with ASTM C 1540/ FM-1680 rated no hub bands for all cast iron piping material above slab-on-grade.

2.2 PVC PIPE AND FITTINGS

A. Polyvinyl chloride sewer pipe and fittings (4" to 15" diameters) shall be as manufactured by Charlotte Pipe and Foundry Company or equal.

B. PVC piping and fittings shall be furnished by the same manufacturer.

C. PVC joint cleaner and solvent cement shall be furnished by the same manufacturer.

D. PVC Schedule 40, DWV, ASTM D 1784. Solvent cement shall meet ASTM D 2564 for (PVC-DWV) plastic and pipe fittings. If permitted by governing code authority, may be used for:

1. Air handling unit condensate drains above grade only if room is not used as return air plenum.

2. Inside gravity, under floor slab sanitary and storm waste drainage systems, with waste temperatures below 140 degrees F.

3. Condensate drains from rooftop units shall be UV resistant where exposed.

E. CPVC Schedule 40, ASTM D 1784 and ASTM F2618. Solvent cement shall meet ASTM F493 for chlorinated polyvinyl chloride (CPVC) plastic pipe and fittings. If permitted by governing code authority, may be used for:

1. Inside gravity, under floor slab sanitary waste drainage systems, where temperature of waste discharged into drainage system exceeds 140 degrees F.

2. Under floor conduit for steam condensate drainage piping below slabs.

F. Fittings:

1. Permanently identify each fitting in accordance and manufacturer's trademark.

2. Include certification with submittal data that fittings and flanges meet applicable requirements and ASTM compliance designation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. PVC and CPVC Joints:

1. Make joints in accordance with cement manufacturer's printed instructions.

2. Where PVC and CPVC piping is used for storm and sanitary below the building slab on grade, extend the PVC and CPVC pipe up through floor slab prior to the concrete pour. Connect to cast iron no-hub piping above slab with appropriate no-hub band coupling. No part of the PVC piping above slab shall be left exposed.

B. Cast Iron Pipe Joints:

1. Install compression gaskets and No-Hub bands in accordance with CISPI and ASTM installation methods and manufacturer's instructions. Refer to the required number of bands and installation criteria previously identified in the PRODUCTS section of this specification.

C. Grading Pipes for Drainage:

1. Uniformly place storm drainage pipes and footing drain pipes at elevations and slopes indicated. If no elevations or slopes are indicated, slope pipes at not less than 1/8" per foot.

2. Uniformly place sanitary sewer pipes at elevations and slopes required by the local codes

3. A double wye or double combination wye and 1/8 bend fitting is not acceptable in a horizontal position for a drainage system.

D. Bracing Joints:

1. Provide braces and all-thread bridle rods as required to reinforce storm piping joints 4" and larger at each change of direction within the building and where otherwise not direct buried below ground. Bracing and restraints shall be as detailed using socket clamps and bridle rods secured to the pipe entering and leaving the elbow fitting. HOLDRITE #117 Series No-Hub Fitting Restraints using galvanized straps with heavy-duty galvanized or black iron bolted clamps may be used for no-hub cast iron pipe. Stainless steel band clamps in lieu of black iron bolted clamps are not acceptable.

2. The bracing described above does not remove the requirement for four or six band no-hub couplings required elsewhere in these specifications.

3. If mechanical lock type couplings are used, then prepare pipe ends and make joints in accordance with pipe coupling manufacturer's printed instructions.

4. Where pipes 8" and larger underground are subject to shock because of sudden changes in liquid flow rate, provide concrete "kicker" blocks at joints, fittings, and changes of pipe direction. Provide "kicker" blocks in accordance with applicable pipe industry trade or research organization recommendations.

E. PVC stormwater piping shall be limited to 12" maximum size when penetrating any rated floor slab or rated wall, due to fire rated sleeve restrictions.

F. Clean inside of pipe before installation. Keep installed piping clean, and protect ends from foreign matter by capping or plugging them.

G. Do not install piping above electrical equipment such as starters, panels, variable frequency motor controllers, motor control centers, or disconnects. Maintain code required clearance above, below and to sides of electrical equipment.

H. In so far as possible, drainage piping shall not be installed overhead, whether exposed or above ceiling, in operating rooms, delivery rooms, nurseries, food preparation or serving areas, or in rooms listed above. Where unavoidable, provide drain troughs or other means to carry away leakage.

I. Do not install piping above or passing through any IT rooms, IDF rooms, or service entrance rooms.

J. Run pipes in straight lines and square with building. Install risers plumb. Make offsets only where indicated and where necessary.

K. Piping passing through or under grade beams or through foundation walls shall be provided with a schedule 40 steel pipe sleeve two sizes greater than the piping passing through the sleeve.

L. Identify all storm, waste and vent piping in accordance with and as specified in Section 22 05 53.

END OF SECTION

SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes requirements for:

1. Cleanouts
2. Trap primers
3. Barrier-Type Trap Seal Protection Device
4. Air Admittance Valves
5. Back water valves

1.2 RELATED REQUIREMENTS

A. Section 22 05 00 - Common Work Results For Plumbing

B. Section 22 11 16 - Domestic Water Piping

C. Section 22 13 16 - Storm And Sanitary Waste And Vent Piping

1.3 SUBMITTALS

A. Submit product data for review in accordance with the requirements of Division 01.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are indicated in subsequent paragraphs.

2.2 CLEANOUTS

A. Acceptable manufacturers:

1. Zurn (Zurn model numbers are used below)
2. Josam
3. Wade
4. Jay R. Smith
5. Sioux Chief
6. Watts

B. Exterior: Z1400Z heavy duty cast iron cleanout housing with internal cleanout body and plug.

C. Finished concrete floor: ZN1400 cast iron body with round adjustable polished nickel bronze top, ABS plug and carpet marker where required.

D. Ceramic tile: ZN1400 Series, cast iron body, polished nickel bronze top, 1/2" terrazzo recess and closure plug.

E. Vinyl tile floor: ZN1400-X, cast iron body, round nickel bronze top, 1/8" tile recess and closure plug.

F. Wall: Z1446, cast iron caulking ferrule with stainless round access cover and screws.

G. Access covers: Minimum size 12" x 12" located for access to valves, shock absorbers, trap primers, wall cleanouts, etc.

H. Furnish cleanouts occurring in waterproof floors with clamping devices.

2.3 TRAP PRIMERS

A. Acceptable manufacturers:

1. Josam
2. Zurn
3. Wade
4. Jay R. Smith
5. Precision Plumbing Products
6. Sioux Chief

B. Provide trap primer of brass construction, with removable operating parts, and integral vacuum breaker.

C. See Plumbing fixture section for specifications.

2.4 BARRIER-TYPE TRAP SEAL PROTECTION DEVICE

A. Acceptable manufacturers:

1. ProSet Trap Guard
2. Wade
3. Rectorseal Sureseal

B. Provide a barrier-type trap seal protection device that shall protect the floor drain trap seal from evaporation. Barrier-type floor drain trap seal protection devices shall conform to ASSE 1072. The seal shall hold at least 10.00” w.c. of back pressure.

2.5 AIR ADMITTANCE VALVES

A. An air admittance valve shall be acceptable as a vent termination for any individual vent, common vent, circuit vent, loop vent and island fixture vent that is provided to prevent siphonage of a fixture trap. An air admittance valve can be used as an alternative to extending a vent through the roof (or sidewall) to the open atmosphere.

B. Acceptable Manufacturers:

1. Studor, Inc.

2. [_____]

3. [_____]

2.6 BACK WATER VALVES

A. Cast Iron Back Water Valves: Zurn Z1095-BV Duco cast iron body with automatic bronze backwater valve, hub inlet and offset spigot outlet, bronze bolted cover.

B. PVC/ABS Back Water Valves: Zurn BW2930 PVC or ABS valve body with valve seat and flapper, furnished with threaded access cover.

PART 3 - EXECUTION

3.1 INSTALLATION AND TESTING

A. Cleanouts

1. Provide line size cleanouts up to 4"; 4" cleanout for lines larger than 4".

2. Locate cleanouts at all changes in direction greater than 45 degrees and in straight runs as shown 100 feet outside the building on drawing or spaced not greater than required by applicable Plumbing Code.

3. Extend inaccessible cleanouts up through floor and/or wall to provide easy accessibility.

B. Trap Primers

1. Install primers in accessible location or as shown on drawings.

2. Trap primers shall be Plumbing and Drainage Institute approved.

C. BARRIER-TYPE TRAP SEAL PROTECTION DEVICE

1. Contractor shall coordinate trap seal model and size with the floor drains

2. The devices shall be installed in accordance with the manufacturer's instructions. Install trap seal device after testing and cleaning the sanitary system keeping the device clear of debris.

D. Catch Basins

1. Install such that frame and grating elevation is minimum 1" lower than surrounding grade in non-paved areas.

2. Install such that frame and cover elevation is 1" higher than surrounding grade in non-paved areas.

3. Slope bottom of basin to drain outlet.

4. Construct catch basins per detail on drawings.

E. Air Admittance Valves

1. Install air admittance valves in accessible locations. Provide access panels when required for access to valve. Install only where standard fixture vent system cannot be installed. Air admittance valves shall be limited to non-standard venting.

F. Back Water Valves

1. Extend the valve access cover to finish floor level by using soil pipe cut to the desired length.

END OF SECTION

SECTION 22 34 38
WATER HEATER, GAS FIRED, COMMERCIAL, LIGHT COMMERCIAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Commercial Gas Fired Storage Condensing Water Heater

B. Commercial Domestic Hot Water Storage Tanks

C. Diaphragm-type expansion tanks.

1.2 RELATED REQUIREMENTS

A. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment

B. Section 22 07 00 - Plumbing Insulation

C. Section 22 11 16 - Domestic Water Piping

D. Division 26: Electrical

1.3 REFERENCE STANDARDS

A. ANSI Z21.10.1 - Gas Water Heaters - Volume I - Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less.

B. ANSI Z21.10.3 - Gas-Fired Water Heaters - Volume III - Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous.

C. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels.

D. CSA P.3 - Testing Method for Measuring Energy Consumption and Determining Efficiencies of Gas-Fired Storage Water Heaters.

1.4 SUBMITTALS

A. Submit product data for review in accordance with the requirements of Division 01.

B. Product data shall include at a minimum:

1. Provide dimension drawings of water heaters indicating components, materials of construction and connections to other equipment and piping; Pressure and Temperature Relief Valves, Thermometers, Pressure Gages,

2. Storage tank

3. Expansion Tanks

4. Heat Traps

5. Gas Shut-off Valves

6. Gas Pressure Regulators

7. Venting requirements

8. Accessories and controls

C. Shop Drawings:

1. Indicate water heater / heat exchanger dimensions, size of tappings, and performance data.

2. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

3. Provide electrical characteristics and connection requirements. Wiring diagrams for power, signal and control functions.

D. Project Record Documents: Record actual locations of components.

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

F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with a minimum of 10 years of experience.

B. Performance: Ensure the products perform to the requirements, ratings and capacity of the equipment scheduled on the drawings.

C. Certifications:

1. Water Heaters: NSF approved.

2. Gas Water Heaters: Certified by CSA International to ANSI Z21.10.1, as applicable, in addition to requirements specified elsewhere.

3. Water Tanks: ASME labeled to ASME BPVC-VIII-1.

4. Pressure Vessels for Heat Exchangers: ASME labeled to ASME BPVC-VIII-1.

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

6. Energy Efficiency: Units shall meet the energy efficiency requirements of ASHRAE Standard 90.1, latest edition.

7. Water heater shall be Factory tested for proper operation of burner, controls, heat exchanger through connection to water for a factory fire test prior to shipping.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 - PRODUCTS

2.1 COMMERCIAL GAS FIRED STORAGE WATER HEATERS

A. Acceptable Manufacturers:

1. A.O. Smith Commercial, Master-Fit BTL,

2. State Industries

3. Bradford White

4. Hesco Industries

5. Lochinvar

B. COMMERCIAL GAS FIRED STORAGE WATER HEATERS

1. Type: Automatic, natural gas-fired, vertical storage, atmospheric or power vent.

2. Performance:

a. The water heater design shall provide a combustion efficiency of at least 95 percent at operating. Water heater capacities are scheduled on the drawings.

3. Tank: Carbon steel, glass lined storage tank, ASME Fired Pressure Vessels, stamped "HLW" for 150 psi working pressure. Tank shall comply with NSF 61 and NSF 372 for barrier materials for potable-water tank linings.

4. Accessories:

a. Water Connections: Brass.

b. Dip Tube: Brass.

c. Drain valve shall be corrosion resistant metal complying with ASSE 1005

d. Anode: shall be replaceable magnesium.

e. Temperature and Pressure Relief Valve: ASME labeled.

5. Certified For The Following Applications:

a. Automatic storage water heater.

6. Controls: Automatic water thermostat with temperature range adjustable from 120 to 180 degrees F (49 to 82 degrees C), automatic reset high temperature limiting thermostat factory set at 195 degrees F (90 degrees C), gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, flue baffle and draft hood. Insulated with high density insulation of proper thickness to meet the energy code.

7. The gas fired stainless steel burner shall include the following:

a. Thermostatically adjustable.

b. High temperature limit and low water cutoff devices for safety controls.

c. Automatic ignition in accordance with ANSI Z21.20.

d. Automatic damper in accordance with ANSI Z21.66. The automatic dampers shall be electrically operated, mechanically activated, or thermally activated, automatic vent damper device with size matching draft hood for 300,000 BTUH and below.

8. Fiberglass insulation with steel jacket

9. Minimum efficiency for atmospheric water heater shall be 82%.

10. Temperature Setting shall be set for a minimum water temperature of 140 degrees F. The temperature setting shall be adjustable. Heaters shall be capable of raising the discharge temperature to 170 to 180 degrees F for thermal eradication.

2.2 COMMERCIAL GAS FIRED STORAGE CONDENSING WATER HEATERS

A. Acceptable Manufacturers:

1. A.O. Smith, Cyclone,

2. Lochinvar Shield

B. Storage Tank: Glass lined or stainless steel with NSF 61 and NSF 372 barrier materials for potable-water tank linings, externally insulated with steel jacket.

1. ASME stamped ("HLW") and National Board registered for 150 psi working pressure .

2. 3/4" drain connection.

3. Insulation shall meet ASHRAE 90.1 requirements.

4. The tapping (openings) shall be factory fabricated of materials compatible with the tank and in accordance with appropriate ASME standards for piping connection, pressure and temperature relief valve, pressure gauge, thermometer, drain valve, anode rods and controls

5. Provide circulation pumps and controls as required by the manufacturer.

C. Low NOx emission, less than 20 PPM.

D. 96% minimum efficiency in accordance with ASHRAE 90.1.

E. Automatic gas/air premix burning system with burner modulation.

1. All burner material exposed to the combustion zone shall be of stainless steel construction.

2. Direct spark ignition with flame supervision.

3. Low gas pressure operation.

4. Automatic ignition in accordance with ANSI Z21.20.

5. The power vent system shall be interlocked with the burner.

F. Additional features shall include:

1. The control shall provide an integral sensor set point adjustment. The set point shall be adjustable in 1 degrees F increments.

2. High temperature limit and low water cutoff devices for safety controls.

3. Inlet and Outlet water temperature sensor.

4. Varying water temperature with use timer.

5. Flue temperature sensor.

6. BAS contact for fault indication, alarm indication, water temperature setpoint.

7. ASME Temperature and Pressure relief valve.

8. Cleaning and inspection openings.

9. Flue and vent connections for vertical or horizontal venting.

10. Plastic venting shall meet manufacturer guidelines, the UL 1738 and E84 requirements, as recommended by manufacturer.

11. 3/4" Condensate drain connection, trap and neutralizing kit.

12. Two terminal strips for electrical connections, one for low voltage connections and one for high voltage connections.

13. Adjustable high limit control (UL353) with manual reset.

14. Low air pressure switch.

15. Temperature Setting shall be set for a minimum water temperature of 140 degrees F. The temperature setting shall be adjustable. Heaters shall be capable of raising the discharge temperature to 170 to 180 degrees F for thermal eradication.

2.3 DIAPHRAGM-TYPE EXPANSION TANKS

A. Manufacturers:

1. Amtrol Ins, Therm-X-Trol

2. Bell & Gossett, a Xylem brand

3. Taco, Inc

4. Wessels Company

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig (80 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish factory or manufacturer's service representative to verify system installation and operation of the burner, all controls and heat exchanger.

B. Verify location and clearance per local code requirements.

C. Install in accordance with manufacturer's recommendations and project contract drawings and details.

D. Vent heater to atmosphere in accordance with drawings.

E. Insulation for water and flue connections shall be in accordance with Section 22 07 00 - Plumbing Insulation.

F. Clean heater and piping and turn over to owner in clean and proper operating condition.

G. All pressure and temperature relief valves discharge shall be piped to a nearby floor drains with air gap or break.

H. Thermometers shall be installed on the water heater inlet and outlet piping and shall be positioned such that they can be read by an operator or staff standing on floor or walkway.

I. Piping type heat traps shall be installed on the inlet and outlet piping of the domestic water heater storage tanks, unless provided integrally with the tanks.

J. Water heater drain piping shall be installed as indirect waste to spill by positive air gap into open drains or over floor drains. Hose end drain valves shall be installed at low points in water piping for gas fueled domestic hot water heaters without integral drains.

END OF SECTION

SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Common work results for requirements specifically applicable to Division 23.

B. Requirements of Division 01 Specifications, General Provisions of the Contract and General and Supplementary Conditions apply to this Division.

1.2 REGULATORY REQUIREMENTS

A. Perform Work specified in Division 23 in accordance with standards listed below of the latest applicable edition adopted by the authority having jurisdiction. Where these Specifications are more stringent, they shall take precedence. In case of conflict, obtain a decision from the Architect.

1. NFPA 30: Flammable and Combustible Liquids Code
2. NFPA 54: National Fuel Gas Code
3. NFPA 70: National Electrical Code
4. NFPA 72: National Fire Alarm and Signaling Code
5. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
6. NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems
7. NFPA 101: Life Safety Code
8. NFPA 101A: Guide on Alternative Approaches to Life Safety
9. NFPA 101B: Standard on Means of Egress for Buildings and Structures
10. NFPA 105: Standard for the Installation of Smoke Control Door Assemblies and Other Opening Protectives
11. NFPA 241: Standard for Safeguarding Building Construction, Alterations, and Demolition Operations
12. NFPA 5000: Building Construction and Safety Code
13. ANSI A17.1: Elevators, Dumbwaiters, Escalators and Moving Walks
14. ANSI Handicapped Code-A117.1
15. ASTM E814-08B: Standard Test Method for Fire Tests Penetration Firestop Systems.

16. U.L. Fire Resistance Index.

17. All applicable Occupational Safety and Health Administration (OSHA) Publications, Rules and Regulations.

18. Americans with Disabilities Act (ADA)

19. Special regulations, supplement, and amendments of the State and/or local authorities having jurisdiction.

1.3 REFERENCE STANDARDS

A. AGA: American Gas Association.

B. ANSI: American National Standards Institute.

C. ARI: American Refrigeration Institute.

D. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers.

E. ASME: American Society for Mechanical Engineers.

F. ASTM: American Society for Testing and Materials.

G. AWWA: American Water Works Association.

H. FM: Factory Mutual

I. IRI: Industrial Risk Insurers

J. MSS: Manufacturer's Standardization Society of the Valve and Fitting Industry.

K. NEMA: National Electrical Manufacturers' Association.

L. NFPA: National Fire Protection Association.

M. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

N. UL: Underwriters' Laboratories, Inc.

O. U.L. Fire Resistance Index

1.4 SUBMITTALS

A. Submit under provisions of Division 01.

B. Incomplete submittals containing unmarked cut sheets or not providing specific detail of what is being proposed will be rejected and will not be reviewed.

C. Include Products as specified in the individual sections of Division 23.

D. Submit shop drawing and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

E. Prepare shop drawings completely independent of the Engineer of Record's CADD files or Revit model. Should the Contractor or Vendor wish to use the Engineer of Record's CADD files or Revit model as the basis for developing their shop drawings, a release form, obtainable from the Engineer or Architect, must be signed. A nominal charge of $50.00 per sheet must be made payable to the engineering firm to cover the cost of preparing the drawings for use by others.

F. Submit copies of shop drawings in accordance with Division 01, including:

1. Building Automation System including direct digital control drawings.

2. Concrete pads and foundations including anchor bolt and sleeve locations.

3. Prepare and submit coordination drawings as specified herein. Facilitate the coordination effort with all other trades, specifically Divisions 21, 22, 26 and 28 and shall include:

4. Roof layouts including:

a. Air Intakes.

b. Vents.

c. Roof mounted equipment.

G. Brochures: Submit manufacturer's product data and brochures including:

1. Complete descriptions.

2. Illustrations.

3. Rating data, accessories, dimensional data, and applicable options and features marked for the specific items scheduled on drawings and specified herein.

4. Capacities stated in the terms specified.

5. Performance curves for all air handling units, fans, and pumps.

1.5 FIELD CONDITIONS

A. Layouts indicated on drawings are diagrammatic and intended to show relative positions and arrangement of equipment, ductwork and piping. Coordinate mechanical work with other trades and measurements obtained at the job site, as applicable, prior to installation. Generally, install work in locations shown on Drawings, using as necessary rises, drops, offsets, transitions, and alternate routings to fit in the available space unless prevented by Project conditions.

B. If prevented by project conditions, prepare drawings showing proposed rearrangement of Work, including changes to Work specified in other sections. Obtain permission of Architect before proceeding.

C. Place anchors, sleeves, and supports prior to pouring concrete or installation of masonry work.

D. Cause as little interference or interruption of existing utilities and services as possible. Schedule work which will cause interference or interruption in advance with Owner, authorities having jurisdiction, and all affected trades.

E. Determine sizes and verify locations of existing utilities on or near site.

F. Keep roads clear of materials and debris.

G. Visit site and be informed of conditions under which Work must be performed.

H. Locate equipment requiring periodic servicing so that it is readily accessible. Provide means of service access, following appropriate manufacturer's recommended service clearance space or, as applicable, means of access using duct, wall, or ceiling access doors.

I. Install ductwork and piping to leave sufficient space for AHJ inspection of wall construction.

1.6 FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required to perform Division 23 work.

1.7 COORDINATION DRAWINGS

A. Prior to commencement of installation, prepare coordination drawings for work under this division, as specified in Division 01, in full cooperation with persons performing work under other Divisions, including but not limited to mechanical, electrical, plumbing, fire protection, telecommunications, audio/visual and miscellaneous steel.

B. Drawings shall not be formally submitted but shall be kept on site for reference. Notify Architect and Construction Manager of conflicts that cannot be resolved.

C. Coordination Drawings shall be prepared to include the following:

1. Drawn to a scale of 1/4" = 1'-0".

2. Room dimensions.

3. Sheet size matching contract documents.

4. Duct sizes with bottom elevation from finished floor.

5. Show equipment, columns, and beams.

6. Duct fitting details.

7. Construction details of plenums and casings.

8. Concrete pad and foundation layouts including anchor bolt and sleeve locations.

9. Dimensioned floor drain locations.

10. Wall mounted equipment.

11. Piping 3" and larger, with elevations from finished floor to bottom of pipe.

12. Space allocation for conduits and cable trays.

13. Ceiling height.

14. Ductwork, air terminal units, and piping 3" and larger shall be shown in proper graphic scale.

15. Clearance requirements for control panels, inspections, and maintenance.

16. Coordination drawings are to indicate air terminal units, fan coil units, air handling units, control panels, and all other devices and materials to proper scale.

1.8 COMPLETENESS OF WORK

A. The Contract Documents depict HVAC systems which are intended to be complete and functioning systems. All products, materials, and labor necessary to render a fully functional system to fulfill the design intent shown on the documents shall be provided by the Contractor.

B. Catalog numbers referenced throughout the Division 23 Drawings and Specifications are intended to convey a general understanding of the type and quality of the product required. Where written descriptions differ from information conveyed by a catalog number, the written description shall govern. No extra shall be allowed because a catalog number is found to be incomplete or obsolete.

1.9 PRODUCT SUBSTITUTIONS

A. Comply with provisions of Division 01.

1.10 RECORD DRAWINGS

A. Provide record drawings that illustrate the work of Division 23 as finally constructed. Deliver record drawings to the Architect in a form suitable for reproduction.

B. Provide record drawings that illustrate the work of Division 23 as finally constructed. Deliver record drawings to the Architect electronic format and also three (3) copies marked in red ink to reflect work as constructed.

C. Record drawings shall reflect all changes made to the Contract Documents, whether generated by addenda, change orders, or field conditions. Maintain a daily record of these changes and keep current set of drawings showing these changes.

D. Deliver record drawings to Architect within 30 days of Substantial Completion.

E. Record drawings are to indicate air terminal units, fan coil units, air handling units, fans, control panels, and all other devices and materials to proper scale.

1.11 OWNING AND OPERATING MANUALS

A. Manuals shall include clear and comprehensive instructions with appropriate graphics and project specific marked data to enable owner to operate and maintain all systems specified in this Division.

B. Copies of final reviewed submittals indicating all model numbers, serial numbers, cut sheets, and all performance criteria on furnished equipment shall be included.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPORTS

A. Structural Steel for Supports: ASTM A36.

1. Use galvanized members installed in fan plenums or areas of high humidity or condensation, and outside. All fasteners shall be stainless steel. Any damage caused by cutting, drilling, or welding or any other means to galvanized surface must be repaired by apply two coats of cold-galvanizing.

2. Use hot dipped galvanized members installed in fan plenums or areas of high humidity or condensation, in tunnels and outside. All fasteners shall be stainless steel. Any damage caused by cutting, drilling, or welding or any other means to galvanized surface must be repaired by applying two coats of cold-galvanizing.

3. Furnish other members with shop coat of primer.

4. Retouch primer after field welding.

2.2 FLASHINGS AND COUNTERFLASHINGS

A. Furnish materials and coordinate installation for flashing and counterflashing roof penetrations for ductwork and piping.

B. Materials:

1. Sheet metal: 24 gauge minimum ASTM A525, Class G90.

2. Sheet lead: 3 pounds per square foot.

3. Stainless steel: Minimum 20 gauge.

4. Sheet copper: 24 OZ/SF.

2.3 WALL AND CEILING ACCESS PANELS

A. Style and type as required for material in which installed.

B. Size: 24"x24" minimum, as indicated, or as required to allow inspection, service and removal of items served.

C. 14 gauge minimum sheet metal for doors, 16 gauge frames of cadmium-plated or galvanized construction. Doors shall have expanded plaster rings where located in plaster walls or flanged finish where located in drywall or block construction.

D. Panels shall have spring hinges with screwdriver locks in non-public areas. Key lock, keyed alike, for panels in public areas.

E. Prime painted or rust inhibitive paint finish.

F. UL labeled when in fire-rated construction, 1-1/2 hour rating.

G. Provide in walls, floors, and ceilings to permit access to all equipment and piping requiring service or adjustment. Examples of such equipment needing access are fire and/or smoke dampers, mechanical system valves, and equipment needing periodic or replacement maintenance.

H. Furnish and locate access panels under this Division. Coordinate with trades who are responsible for building system in which panels are to be installed.

I. Acceptable manufactures: Milcor, Nystrom, Karp, J.L. Industries, or Williams Brothers.

1. For masonry and drywall construction: Milcor Style M.

2. For plastered masonry walls and ceiling: Milcor Style K.

3. For ceramic tile or glazed structural tile: Use stainless steel panels.

2.4 PIPE ENCLOSURES

A. For exposed vertical piping in kitchen: 18 gauge stainless steel (Type 302) with No. 4 finish.

1. Extend from 2" above ceiling to equipment or island partition.

2. Size covers to contain number of pipes served.

B. Minimize number of covers by enclosing maximum number of pipes in each drop.

C. Anchor to equipment or partition.

D. Fasten seams and joints with stainless steel pop rivets.

E. Provide 1-1/2" ceiling flange as closure.

2.5 SLEEVES

A. Materials:

1. Concrete floors, concrete and masonry walls: 18 gauge galvanized steel tube with welded longitudinal seam or Schedule 10 galvanized steel pipe.

2. Drywall partitions: 18 gauge galvanized steel sheetmetal or Schedule 10 galvanized steel pipe.

B. Sleeves shall be sized such that the annular space between outside surface of pipe or pipe insulation and the inside surface of the sleeve is not less than 1/2". Provide larger annular space if required by firestopping product installation instructions or water proofing seal in exterior wall penetration.

C. Sleeves supporting riser piping 4" and larger shall have three 6" long reinforcing rods welded radially at 120 degree spacing to the sleeve and shall be installed with the rods embedded in the concrete slab as the floor slabs are poured.

D. Exterior wall and floor penetrations shall be sleeved and sealed with a Link Seal Modular Seal by GPT Industries or Flexicraft Industries.

1. Exterior wall and floor penetrations: Install Link Seal Modular Seal by GPT or Flexicraft Industries. Seal shall be suitable for use in direct ground contact, water or atmospheric conditions with EPDM seal element. Provide Nitrile rubber seal element where subject to oils and fuel. All bolts, nuts and fasteners shall be Steel with 2-part Dichromate corrosion inhibiting coating or Type 316 Stainless steel.

2.6 ESCUTCHEON PLATES

A. Provide B & C No. 10 or equal chrome plated escutcheon plates where pipes penetrate partitions or ceilings in finished areas.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. Repair or replace damage caused by cutting or installation of work specified in Division 23.

B. Perform repairs with materials which match existing and install in accordance with the appropriate section of these specifications.

3.2 FLASHING AND COUNTERFLASHING

A. Counterflash ducts and pipes where penetration of roofs and outside walls occur.

3.3 CONNECTION TO EQUIPMENT FURNISHED BY OWNER

A. Connect and/or install equipment shown on mechanical drawings that requires mechanical connections.

B. Provide piping, isolation valves, unions, and other piping appurtenances required for a complete installation.

C. Provide steam strainers, steam traps, and pressure reducing valves in steam lines.

3.4 DELIVERY, STORAGE, AND PROTECTION

A. Insofar as possible, deliver items in manufacturer's original unopened packaging. Where deliver in original packaging is not practical, provide cover and shielding for all items with protective materials to keep them from being damaged. Use care in loading, transporting, unloading, and storing to keep items from being damaged.

B. Store items in a clean, dry place, and protect from damage. Mechanical equipment may not be staged or stored outdoors unless intended for outdoor use.

C. Protect nameplates on motors, pumps, and similar equipment. Do not paint or insulate over nameplate data.

D. Protect valves and piping from damage. Cover equipment during work of finishing trades.

E. Keep dirt and debris out of pipes and ducts.

F. Repair, restore, and replace damaged items.

G. Cover factory finished equipment during work of finished trades, such as fan coils, fin tubes, etc.

H. Protect cooling and/or heating coils with temporary filter media during construction.

3.5 SLEEVES

A. Floors and Roof slabs: Sleeve all pipe penetrations including mechanical equipment rooms and other wet areas. Extend sleeve 2" above finished floor and roof, except piping within pipe chases. Sleeve shall be flush with underside of floor.

B. Masonry or concrete walls: Sleeve all pipe penetrations. Sleeves shall be flush on both sides of wall.

C. Non-Rated Drywall partitions: Sleeves are not required, except in systems above 160 degrees F. Voids between pipe, pipe insulation and drywall shall be sealed with appropriate joint sealant material.

D. Seal voids between outside surface of sleeve and wall, partition or floor. Seals shall be airtight.

E. For all fire rated walls, floors and partitions install piping, insulation and sleeves in strict accordance with applicable U.L. floor or partition assembly instructions. Coordinate installation and fire stop material with Division 07 and Firestop Manufacturer's installation instructions.

F. Clearance between sleeve and pipe: Minimum of 1/2 inch for hot piping and 1 inch for cold piping or as otherwise dictated by U.L. Fire Resistance Directory.

G. Wall Penetrations not Sleeved or Firestopped:

1. Seal voids between pipe and partition with appropriate joint sealant material. Seals shall be airtight.

H. Core drilled holes in concrete floors: Sleeves are not required. Seal airtight and to maintain the floor rating integrity.

3.6 ESCUTCHEON PLATES

A. Provide chromium plated escutcheon plates for exposed uninsulated pipes projecting through floors or walls in "finished" spaces. Mechanical rooms, store rooms, electric closets, and janitor closets are not considered "finished" spaces.

3.7 EQUIPMENT GUARDS

A. Use suitable structural frames with minimum 12 gauge, 3/4" galvanized mesh, or expanded metal mesh. Attach to equipment by removable clips and bolts with wing nuts, or other approved connectors.

B. At belts, provide opening for measuring RPM.

C. Provide at all belts, couplings, moving machinery and equipment.

D. Design for easy access to belts and other items requiring replacement.

E. Comply with OSHA Regulations.

3.8 CLEANING HVAC SYSTEMS

A. General Cleanup:

1. Upon completion of contract and progressively as work proceeds, clean up dirt, debris, old materials, etc., and remove from site, keeping premises in neat and clean condition to satisfaction of the Architect. See Division 01 of specifications for further requirements.

2. Seepage, discoloration or other damage to parts of the building, its finish, or furnishings due to Contractor's failure to properly clean piping systems or duct systems shall be repaired without cost to the Owner.

B. Factory Finishes:

1. Clean items with factory finishes. Touch up bare places, scratches and other minor damage to finishes. Use only factory supplied paint of matching color and formula. If finishes are badly damaged or if there are many damaged, scratched or bare places, refinish the entire item.

C. Ducts and Apparatus:

1. Thoroughly clean ducts and apparatus casings before fans and filters are operated.

3.9 OPERATION OF HVAC SYSTEMS DURING CONSTRUCTION

A. Install all specified filters prior to system operation. In addition to specified filters, install a roughing filter upstream of mixed air filter. Roughing filter shall consist of two layers of roll filter media clipped and sealed to entering side of filter frame. Change roughing filter as necessary to minimize dust collection on specified filters.

B. Cover return and exhaust air grilles with temporary filter media. Attach media to avoid damage to grille or ceiling. Change temporary media as required to protect against dust buildup on ductwork. Remove temporary media from grilles after flooring is installed, walls are sanded and painted and other dust generating construction has been completed.

C. During periods of excessive dust generation such as drywall sanding, seal off return and exhaust openings and grilles to prevent dust from accumulating in ductwork.

D. If outside air source contains less dust than building air, adjust A/C unit dampers to operate with as much outside air as possible without causing a freezing condition for coil or exceeding capacity of coil to adequately condition supply air.

E. Furnish and install a new set of specified filter media prior to start of system test and balance. Furnish a new, clean set of the specified media and turn over to Owner's Representative.

3.10 TESTING MECHANICAL SYSTEMS

A. Test all systems and equipment installed to demonstrate proper operation.

B. Advise Architect of scheduled systems testing and completed system demonstration/operation schedules so that he may witness, if desired.

C. Correct and retest work found defective when tested.

D. Make repairs to piping systems with new materials. Peening, doping, or caulking of joints or holes will not be acceptable.

E. Natural Gas Piping: Test piping with air, CO_2, or nitrogen at 125 psi pressure for six hours without leaking.

F. Ductwork Pressure Testing: Refer to Section 23 31 13 for required pressure testing for ductwork.

G. System Balance and Testing: Prepare to assist test and balance firm by assuring systems are complete and operational.

H. Test all smoke and combination fire/smoke, dampers by observing damper operation during fire alarm system commissioning.

I. Records of Testing: Maintain records of system testing and results thereof. Deliver results as part of project closing file and on an intermediate basis as requested by Architect.

END OF SECTION

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

1.2 RELATED REQUIREMENTS

A. Section 26 05 83 - Wiring Connections

B. Section 26 29 13 - Enclosed Controllers.

C. Section 26 29 23 - Variable Frequency Motor Controllers

1.3 REFERENCE STANDARDS

A. Each motor, controller and all components shall be designed, manufactured and tested in accordance with the following applicable standards:

1. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015.
2. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators 2017.
3. IEEE Standard 112, Test Method "B"; 1996.
4. IEEE Standard 444 (ANSI C34.3); 1992.
5. IEEE Standard 519; 1992.
6. NEMA MG 1 - Motors and Generators 2018.
7. NEMA MG1, Part 31 - Definite Purpose, Inverter Fed Motors; 2012.
8. NEMA - ICS-3-303
9. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
10. Energy Policy Act of 1992

B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the authorities having jurisdiction, and suitable for it's intended use on this Project.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Submit motor information with submittals and shop drawings for Division 23 equipment.

C. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

D. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

E. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

F. Operation Data: Include instructions for safe operating procedures.

G. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Baldor Electric Company/ABB Group; [_____]: www.baldor.com/#sle.

B. Leeson Electric Corporation; [_____]: www.leeson.com/#sle.

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:

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

2. Motors larger than 1/2 Horsepower: 460 volts, three phase, 60 Hz.

B. Windings and Insulation:

1. All motors shall have copper windings.

2. Motors shall be equipped with Class B, 80 deg. C rise or Class F, 105 deg. C rise insulation suitable for use in a 40 deg. C ambient temperature.

3. Motors used for cooling tower applications shall be equipped with Class F, 105 deg. C insulation suitable for use in a 40 deg. C ambient temperature. Windings shall be treated with an epoxy varnish to inhibit the moisture absorption.

C. Bearings:

1. Single phase, fractional horsepower motors shall be equipped with quiet operating, all angle babbitt lined sleeve bearings.

2. Polyphase motors shall be equipped with deep groove type ball bearings, generously sized for the loads to which applied and for severe duty application. Provide the necessary seals on the shaft to keep the bearing system free of contamination and moisture. Lubricant shall be high temperature, non-bleeding grease.

a. Provide inlet and outlet plugs on poly phase motors so that grease fittings can be easily inserted for bearing lubrication except as otherwise specified. The end shields shall be carefully machined to add extra grease capacity. Lower outlet plugs shall be equipped with combination breather/drains on TEFC and TEAO motors.

D. Motors on belt driven equipment shall have slide rails with adjusting screws for belt tension adjustment.

E. Motors specified with variable frequency motor controllers shall comply with NEMA MG1, Part 31 for Definite Purpose, Inverter Fed motors including insulation meeting the requirement for 1600 Vpk at 0.1 uS rise time. In addition to compliance with MG1, Part 31, motors also shall be designed for starting across the line and specifically designed to reduce inrush current.

1. To protect motor bearings and shafts from damage due to induced electrical currents along the motor shaft, provide Aegis shaft grounding ring (SGR), conductive microfiber motor shaft grounding ring on the driven end of all inverter fed motors. For inverter fed motors 100 HP and larger, also provide either an insulated motor bearing or a ceramic bearing on non-driven end of motor. Comply with manufacturer's installation instructions and with NEMA MG1, Part 31 for inverter fed motor bearings.

F. Sound power levels shall not be greater than recommended in NEMA M61-12.49. Inverter duty rated motors shall not increase by more than 3 dB when operating on a variable frequency motor controller.

G. Provide motors with drive shafts long enough to extend completely through belt sheaves when sheaves are properly aligned and balanced.

H. Motors exposed to the weather shall be weather protected.

I. Install premium efficiency electric motors for motors 1 horsepower and above. Premium efficiency motors shall have efficiency and losses determined in accordance with the latest revisions of IEEE Standard 112. Polyphase squirrel cage motors rated 1 through 150 horsepower shall be tested by dynamometer method B. The efficiency shall be determined using segregated losses in which stray load loss is obtained from a linear regression analysis to reduce the effect of random errors in the test measurements. Guaranteed minimum load efficiency shall be as follows:

1. HP:3/4 Eff:80.0%
2. HP:1 Eff:84.0%
3. HP:1 1/2 Eff:86.5%
4. HP:2 Eff:86.5%
5. HP:3 Eff:89.5%
6. HP:5 Eff:89.5%
7. HP:7 1/2 Eff:91.7%
8. HP:10 Eff:91.7%
9. HP:15 Eff:93.0%
10. HP:20 Eff:93.6%
11. HP:25 Eff:93.6%
12. HP:30 Eff:94.1%
13. HP:40 Eff:94.5%
14. HP:50 Eff:95.0%
15. HP:60 Eff:95.4%
16. HP:75 Eff:95.4%
17. HP:100 Eff:95.4%
18. HP:125 Eff:95.4%
19. HP:150 Eff:95.4%

J. Construction:

1. Open drip-proof type except where specifically noted otherwise.

2. Design for continuous operation in 104 degrees F (40 degrees C) environment.

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

K. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

L. Motors shall be specifically designed for quiet operation and for severe duty. Standard open drip proof motors shall be equipped with aluminum or stainless steel stamped nameplates. Totally enclosed fan cooled and air over motors shall be equipped with stainless steel stamped nameplates with either zinc or cadmium plated hardware. Motor nameplates shall clearly indicate frame size, horsepower, frequency, voltage, speed, starting torque class, insulation class, service factor and winding material.

M. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.3 APPLICATIONS

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

B. Single phase motors for shaft mounted fans, oil burners, and centrifugal pumps: Split phase type.

C. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

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

E. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.

F. Three phase motors for blowers, fans, pumps, and other HVAC equipment: Squirrel cage type.

G. Motors located in exterior locations, wet air streams downstream of sprayed coil dehumidifiers, air cooled condensers, humidifiers, and direct drive axial fans: Totally enclosed type.

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

I. Motors located outdoors and in draw through cooling towers: Totally enclosed weatherproof epoxy-sealed type.

2.4 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

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

C. Breakdown Torque: Approximately 200 percent of full load torque.

2.5 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

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

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

C. Multiple Speed: Through tapped windings.

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

2.6 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

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

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

2.7 THREE PHASE POWER - SQUIRREL CAGE MOTORS

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

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

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

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

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

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

J. Sound Power Levels: To NEMA MG 1.

K. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

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

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install base mounted motors securely on firm foundation.

C. Align motors on direct drive equipment using dial type gauges.

D. Check line voltage and phase and ensure agreement with nameplate. Test motor for proper rotation under Division 26.

3.2 ADJUSTMENTS

A. Motors, together with driven equipment, shall be dynamically and statically balanced. Imbalance shall be reduced to minimum specified by equipment manufacturers.

END OF SECTION

SECTION 23 05 49
VIBRATION ISOLATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vibration isolators, pipe supports, and equipment anchors, of appropriate sizes and weight loading to meet the specified deflection requirements, in accordance with instructions of isolator manufacturer.

B. Vibration isolation for all Division 22 and 23 systems as noted below. Provide all miscellaneous items (angle iron, bolts, rods, etc.) required for a complete system. Contractor and vendors shall thoroughly coordinate all vibration isolation systems.

C. Coordination of installation with other trades (placement of anchor bolts in concrete slabs, etc.)

1.2 RELATED REQUIREMENTS

A. Section 01 45 33 - Code-Required Special Inspections and Procedures

B. Section 03 30 00 - Cast-in-Place Concrete

C. Division 22: Plumbing

1.3 MANUFACTURER RESPONSIBILITIES

A. Manufacturer of vibration isolation and seismic control products shall have the following responsibilities:

1. Manufacturer of vibration isolation shall have the following responsibilities:

a. Determine vibration isolation and restraint sizes and locations for mechanical and plumbing equipment.

b. Determine vibration isolation sizes and locations for mechanical and plumbing equipment.

c. Provide isolation systems and seismic restraints for all plumbing and mechanical of equipment (vibration isolated and non-isolated) and systems (piping and ductwork).

d. Provide isolation systems for all plumbing and mechanical of equipment (vibration isolated and non-isolated) and systems (piping and ductwork).

e. Provide seismic restraints for Division 22 and 23 piping at wall penetrations and at vertical risers. Provide sleeves, sleeve packing, guides and seismic calculations for pipe support.

f. Provide seismic restraints for Division 22 and 23 control panels and equipment starters. Provide attachment bolts, resilient mounts, and associated seismic calculations.

g. Provide installation instructions and drawings.

h. Provide calculations to determine restraint loads resulting from seismic forces presented in:

1) International Building Code

B. Use the most stringent of governing codes, project seismic requirements, or 0.5G minimum seismic acceleration applied at the equipment center of mass. Seismic calculations shall be certified by an engineer who is licensed in the State of this project and has a minimum of 5 years documented experience in the design of seismic restraints for flexibly mounted equipment and piping.

C. Provide certification of seismic restraints capability to safely accept loads resulting from seismic forces determined by methods defined above. Certification must be substantiated by calculations or test reports verified by a licensed engineer.

D. Vibration isolation specialist shall coordinate his work with that of other trades to verify that equipment speeds, in revolution per minute (rpm), are based upon actual equipment installed at the project site.

E. Verify that equipment rpm and spring deflection selected are arranged so that resonance is avoided.

F. Exact mounting sizes, dimensions and quantity of isolators and static deflection required shall be determined by the isolator manufacturer based upon equipment that will be furnished and installed by the contractor under this Contract.

1.4 SUBMITTALS

A. Submit product data and related information noted below in accordance with the provisions of Division 01.

B. Contractor's Certification: Vibration isolator submittals shall include a certification, signed by an officer representing the Contractor and stipulating that the submittal prepared by the manufacturer has been reviewed, and checked on an item by item basis against each piece of mechanical equipment, piping, ductwork and panel shown or specified in the Contract Documents, which requires vibration isolation and/or support.

C. Manufacturer's Certification: The manufacturer or manufacturers (if there are more than one) shall each certify that the selections of seismic restraint and vibration isolation equipment are based upon the drawings and specifications, and that each piece of mechanical equipment has been examined for rotational speed, equipment type, mounting location, and supporting span between column centers, and that an appropriate isolator has been selected.

D. Product Data: Furnish manufacturer's product data covering each seismic restraint and isolator type for style, characteristic, and finish. Seismic restraint and isolator quantities, dimensions, deflections, capacities and types shall remain the responsibility of the manufacturer and the contractor.

E. Shop Drawings: Provide layout drawings, drawn to a scale of not less than 1/8-inch to 1-foot, showing the proposed layout of equipment and piping systems and the location and type of each vibration isolation and restraint device. Carefully examine other sections requiring coordinated shop drawings, including but not limited to Section 23 31 13, "Sheet metal Ductwork", Section 23 31 14, "Sheet metal - Special Ductwork", and prepare restraint/isolation shop drawings to the same scale showing the location of each vibration isolation equipment base, pipe hanger, flexible connection, and isolator restraint device.

1.5 QUALITY ASSURANCE

A. Responsibility for Products: Select deflection for spring isolators in accordance with recommendations in the current issue of ASHRAE Handbook of Fundamentals, unless noted otherwise on drawings.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than 10 years of documented experience.

1. Member of Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

1.6 STORAGE AND PROTECTION

A. Storage: Store vibration isolation equipment indoors in the manufacturer's original shipping containers. Preclude the entrance of construction dirt and debris. Vibration isolation equipment and bases, which show signs of rust, cement or concrete fouling, dirt and construction debris shall be disassembled and cleaned, approved or removed from the project site and replaced with new.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Amber Booth, Kinetics Noise Control, Korfund Company, Mason Industries, Vibration Eliminator Co., or Vibration Mountings & Controls.

B. Furnish vibration isolators by single manufacturer.

C. Substitutions: Refer to Division 01.

2.2 PRODUCTS

A. Type 4: Mason SLR, restrained spring isolator with combination leveling bolt and equipment fastening bolt, vertical limit stops with internal neoprene pad, 1/4" external

neoprene isolation pad under base plate. Springs shall be rigidly attached to the mounting base plate and spring compression plate.

1. Designed to resist all seismic forces.

2. Product to have California OSHPD Pre-Approval rating.

B. Type 5: Mason SSLH, housed spring isolator, vertical limit stops, designed to provide all directional snubbing.

1. Product to have California OSHPD Pre-Approval rating.

C. Type 7: Mason SCB, SCBH, SCBV cable assembly, galvanized aircraft cable with steel cable end connections, designed to resist seismic loads with a minimum safety factor of 2.

1. Product to have California OSHPD Pre-Approval rating.

D. Type 8: Mason SSB, solid steel channel brace with steel connector assemblies, designed to resist seismic loads with a minimum safety factor of 2.

1. Product to have California OSHPD Pre-Approval rating.

E. Type 11: Mason RSC, spring isolation curb for roof mounted equipment, heavy gauge Z section sheet metal base that supports adjustable and removable restrained spring mounts, top section to be continuous rail support for equipment; springs to rest on 1/4" neoprene pads; hardware shall be plated and springs furnished with rust resistant finish; curb to be waterproofed using continuous galvanized flexible counter flashing, joined at corners with EDAM bellows; spring locations to have removable, waterproof access ports.

1. Product to have California OSHPD Pre-Approval rating

2.3 MATERIALS AND EQUIPMENT

A. Materials and equipment shall conform to the respective specifications and other requirements specified below:

1. Squarehead bolts and heavy hexagon nuts, ANSI B18.2.1 and ANSI B18.2.2, and ASTM A 307 or ASTM A 576.

2. Sway Brace Material used for members shown on mechanical drawings, except for pipes, shall be structural steel conforming with ASTM A 36. Steel pipes shall conform to ASTM A 501.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL

A. Size vibration control equipment in accordance with weight distribution, pull or the imposed torque as shown on equipment shop drawings. Minimum static deflections may be revised subject to prior approval.

B. Provide revised vibration control equipment to match revised or substituted equipment.

C. Install vibration control equipment in accordance with the manufacturer's installation instructions and as specified.

D. Install equipment on vibration isolation curbs to provide watertight seal.

3.2 APPLICATIONS

A. Equipment: Use the vibration and restraint types listed above on the following applications:

1. A/C units, packaged DX rooftop: Type 11

2. Fans, Floor mounted

a. Slab on grade: Type 5

b. Outdoors and on roof on steel or equipment support: Type 4

3. Unit heaters

a. Type 8, 13

B. Ductwork

1. Seismically restrain all ductwork with type 7 or 8 restraints as listed below:

a. Rectangular or flat oval ducts with a cross sectional area 6 sq. ft. or larger

b. Round ducts with diameter of 28" or larger

2. All ductwork that is suspended such that the distance from the top of the duct to the point of attachment to structure above is 12" or less does not need to be seismically restrained.

3. Install transverse restraints at 30' intervals but not less than at both ends and at each duct turn.

4. Install longitudinal restraints at 60' intervals but not less than at each duct turn.

5. Reinforce duct at restraint locations.

C. Seismically restrain all piping with type 7 or 8 restraints as listed below:

1. Gas piping 1" and larger

2. All piping in mechanical rooms 1-1/4" and larger

3. All other mechanical and plumbing piping 2-1/2" and larger

4. Install transverse restraints at 40' intervals

5. Install longitudinal restraints at 80' intervals

D. Use hold down clamps to attach multiple pipes to trapeze hangers.

3.3 ANCHORING

A. Installation: Installation shall comply with manufacturer's published recommendations and shall be installed so that isolators are plumb and are operating at a manner for which they were designed.

B. Unless otherwise specified, all equipment shall be securely bolted to isolators, steel bases or concrete inertia bases.

C. Spring isolators under equipment mounted on steel grillage or similar supports shall be securely fastened to the support structure to prevent movement.

3.4 SPREADERS

A. Spreaders shall be provided between racked or adjacent piping runs to prevent contract during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart or four times the maximum displacement due to seismic force. Spreaders to be applied at same interval as sway braces. Spreaders shall be applied to surface of bare or insulated hot pipe and over insulation utilizing high-density inserts and pipe protection shields were vapor-barrier-type insulation is employed.

3.5 ANCHOR BOLTS

A. If the size and number of the anchor bolts are not shown on the drawings then anchor bolts shall conform to the schedule for the various equipment weights or the manufacturer's installation recommendations, whichever is the most stringent.

3.6 MISCELLANEOUS EQUIPMENT

A. The following specific items of equipment to be furnished under this contract shall be manufactured and assembled, and constructed so as to be capable of withstanding the horizontal equivalent static force of 0.11 times the operating weight of the equipment, at vertical center of gravity of the equipment without causing permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake.

1. Air-Handling Units

2. Water Heaters

3.7 INSTALLATION

A. Set anchor bolts when concrete is placed.

B. Install isolators in accordance with recommendations of isolator manufacturer and equipment manufacturer.

C. Isolate mechanical equipment as indicated.

D. Remove all debris from under equipment, and thoroughly clean steel bases, inertia bases and check for free movement.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Adhesive-backed duct markers.

D. Stencils.

E. Pipe Painting and Markers.

F. Printed Labels / Ceiling Markers / Tacks

G. Control Diagrams.

1.2 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting: Identification painting.

1.3 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials 2017.

1.4 SUBMITTALS

A. See Division 01.

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number. Follow existing facility standards if applicable.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Samples: Submit samples of ceiling markers/tacks, duct labels, nameplates, pipe markers, and valve tags.

F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

G. Project Record Documents: Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Access Doors: Stencil painting compliant with NFPA 90A where applicable.

B. Major HVAC equipment including, but not limited to AHU's, boilers, chillers, fans, pumps, and RTU's: Nameplates.

C. Air Terminal Units: Nameplates

D. Automatic Controls: Tags. Key to control schematic.

E. Control Panels and major control components: Nameplates.

F. Automatic Control Dampers: Ceiling markers/tacks, where located above lay-in ceiling.

G. Ductwork: Stencil painting.

H. Fire, Smoke, and Combination Dampers: Labels.

I. Heat Transfer Equipment: Nameplates.

J. Major Control Components: Nameplates.

K. Piping: Pipe markers.

L. Pumps: Stencil painting.

M. Unitary Equipment: Nameplates.

N. Tanks: Stencil painting.

O. Thermostats: Printed Labels.

P. Valves: Tags and ceiling tacks where located above lay-in ceiling.

Q. Water Treatment Devices: Nameplates.

2.2 MANUFACTURERS

A. Brady Corporation, Kolbi Pipe Marker Company, Marking Services, Inc., MIFAB, Inc., or Seton Identification Products

B. Substitutions: Refer to Division 01.

2.3 NAMEPLATES

A. Rigid plastic with engraved lettering.

B. Fasteners: Commercial quality, rust resisting nuts and bolts with backwashers, self-tapping screws, or rivets. If equipment surface does not allow for direct attachment, use copper or brass rings to attach tags.

C. Use names, numbers, and abbreviations appearing in schedules on Contract Drawings or as otherwise directed by the Owner.

D. Letter Color: White.

E. Letter Height: 1/2 inch (13 mm).

F. Background Color: Black.

G. Plastic: Comply with ASTM D709.

2.4 TAGS

A. Tags shall be provided showing the valve service and number or equipment number.

1. At substantial completion, submit chart showing all valve and equipment numbers to Owner and Engineer.

2. Brady Corporation; [_____]: www.bradycorp.com/#sle.

3. Securely fasten tags to valves with a brass "S" hook or chain.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges. Provide with permanently stamped black filled letters and numbers.

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

2.5 ADHESIVE-BACKED DUCT MARKERS

A. Manufacturers:

1. Brimar Industries, Inc; [_____]: www.pipemarker.com/#sle.

2. Substitutions: Refer to Division 01.

B. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch (0.76 mm); printed with UV and chemical resistant inks.

C. Style: Individual Label.

D. Color: Yellow/Black.

2.6 STENCILS

A. Where stenciling is used to identify large pieces of equipment, such as boilers, chillers, and air handling units, stenciling shall be in a conspicuous place and visible from control panel area.

B. Use names, numbers, and abbreviations appearing in schedules on Contract Drawings or as otherwise directed by the Owner.

C. Piping stencils shall include flow direction arrow and identification of fluid being conveyed

1. Steam piping shall indicate operating pressure in addition to contents and flow direction

D. Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch (20-30 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 1/2 inch (15 mm) high letters.

2. 1-1/2 to 2 inch (40-50 mm) Outside Diameter of Insulation or Pipe: 8 inch (200 mm) long color field, 3/4 inch (20 mm) high letters.

3. 2-1/2 to 6 inch (65-150 mm) Outside Diameter of Insulation or Pipe: 12 inch (300 mm) long color field, 1-1/4 inch (30 mm) high letters.

4. 8 to 10 inch (200-250 mm) Outside Diameter of Insulation or Pipe: 24 inch (600 mm) long color field, 2-1/2 inch (65 mm) high letters.

5. Over 10 inch (250 mm) Outside Diameter of Insulation or Pipe: 32 inch (800 mm) long color field, 3-1/2 inch (90 mm) high letters.

6. Ductwork and Equipment: 2-1/2 inch (65 mm) high letters.

E. Stencil Paint: Semi-gloss enamel or latex. Color shall be black or white, whichever provides the highest contract to the adjacent surface. Comply with colors in ASME A13.1 where applicable.

2.7 PIPE MARKERS

A. Painting of HVAC piping:

1. Paint piping as specified in this section and as specified in Division 09.

2. Paint all exposed piping (or exterior surface of insulation) in mechanical rooms and rooms without ceilings in its entirety.

3. Colors:

a. Refrigerant Piping: Same as current ASHRAE Standard 34 container color based on refrigerant type.

b. [_____]

c. [_____]

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering. At a minimum, marker shall have flow direction arrows and identification of fluid being conveyed.

C. Steam piping shall indicate operating pressure in addition to contents and flow direction.

D. Colors shall conform to ASME 13.1 where applicable.

2.8 PRINTED LABELS / CEILING MARKERS / TACKS

A. Printed Labels

1. Printed labels / asset tags to be coordinated with Owner and applied by Contractor.

2. Prior to Substantial Completion date, Contractor to work with owner, as required, to locate devices above the ceiling requiring a printed label / asset tag.

B. Ceiling Marker / Tack description: Steel with 3/4 inch (20 mm) diameter color coded head.

1. Contractor to provide an install.

2. Color code as follows:

a. HVAC Equipment: Yellow.

b. Fire Dampers and Smoke Dampers: Red.

c. Valves: Blue.

2.9 CONTROL DIAGRAM FRAMES

A. Provide printed diagrams for all major HVAC equipment. Mount diagrams on walls in conspicuous, easily accessible places in each separate equipment room housing the equipment which the individual diagrams are applicable. Diagrams shall be laminated and represent as-built conditions. Lettering to be no smaller than 10 pt font.

B. The following diagrams are required:

1. Written sequences of operation.

2. Graphic control diagram indicating relative device locations and labels.

C. Provide and install mounting hardware to secure each diagram to the wall. If adequate wall space is not available adjacent to the associated equipment, coordinate an alternate mounting location with Owner.

PART 3 - EXECUTION

3.1 PREPARATION

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

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

3.2 INSTALLATION

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

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Division 09.

D. Install plastic pipe markers in accordance with manufacturer's instructions at no less than 25 foot intervals, at valves, and at least once in each separate space through which the pipe passes. Label all vent piping and pressure relief piping.

E. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

F. Use tags on piping 3/4 inch (20 mm) diameter and smaller.

1. Identify service, flow direction, and pressure.

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

3. Locate identification not to exceed 25 feet (7.5 m) on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

G. Label ductwork at no less than 25 foot intervals, on both sides of barriers and rated wall penetrations, and at all ductwork penetrations into and exiting from enclosed chases.

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

I. Confirm with Owner or Architect prior to placing ceiling tacks or labels on surfaces other than lay-in panel ceilings.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic, plumbing, and refrigeration systems.

C. Measurement of operating condition of existing HVAC and plumbing systems prior to construction.

D. Measurement of final operating condition of HVAC and plumbing systems.

E. HVAC ductwork pressure testing.

1.2 RELATED REQUIREMENTS

A. Division 01: General Requirements.

B. Section 23 05 00 - Common Work Results for HVAC

1.3 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition 2016.

B. AABC MN-1 - AABC National Standards for Total System Balance 2002.

C. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems 2008, with Errata (2019).

1.4 SUBMITTALS

A. Refer to Division 01 for submittal procedures.

B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

1. Submit to Architect and Engineer.

2. Include at least the following in the plan:

a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.

c. Identification and types of measurement instruments to be used and their most recent calibration date.

d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

e. Final test report forms to be used.

f. Any balancing or procedural concerns.

g. Time schedule for TAB work to be done in phases (by floor, etc.).

h. Time schedule for deferred or opposed seasonal TAB work.

i. Specific list of rooms requiring specific pressure differentials and the target differential pressure for each room.

j. Procedures for formal deficiency reports, including scope, frequency and distribution.

1.5 REPORTS

A. Field Logs: Submit at least twice a week to Construction Manager.

B. Progress Reports.

1. Report any items not installed, improperly installed, or not functioning properly.

2. Items which have not been corrected by Friday of each week will be officially turned over to the Contractor with a copy to the Owner.

C. Final Report:

1. The report shall be certified and approved by the test and balance engineer of the firm.

2. Indicate deficiencies that prevented proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

3. Revise TAB plan to reflect actual procedures and submit as part of final report.

4. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Owner, Architect, and Engineer and to Contractor for inclusion in operating and maintenance manuals.

5. Provide reports in hard cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of

reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

6. Include actual instrument list, with manufacturer name, serial number, and date of calibration. Calibration dates must be current.

7. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.

8. Units of Measure: Report data in I-P (inch-pound) units only.

9. Include the following on the title page or introduction of the report:

   a. Name of Testing, Adjusting, and Balancing Agency.

   b. Address of Testing, Adjusting, and Balancing Agency.

   c. Telephone number of Testing, Adjusting, and Balancing Agency.

   d. TAB Agency technician(s) responsible for the content.

   e. Project name.

   f. Project location.

   g. Project Architect.

   h. Project Engineer.

   i. Project Contractor.

   j. Project mechanical sub-contractor.

   k. Project altitude.

   l. Report issue date and dates tests were performed.

   m. Controls supplier

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with:

1. AABC (NSTSB), AABC National Standards for Total System Balance.

2. If these specifications set forth more stringent requirements than the above referenced standard(s), these specifications shall become the minimum requirements.

B. During Construction, the TAB shall inspect the installation of major HVAC equipment, piping systems, sheetmetal work, and temperature controls as well as other parts of the HVAC and plumbing systems. The inspections shall be performed periodically as work progresses. A minimum of two inspections are required as follows:

1. When 60% of the ductwork is installed.

2. When 90% of the equipment is installed.

3. The TAB shall submit a written report of each inspection to the Owner, Engineer, Contractor, and Architect.

C. Upon completion of the installation and start-up of the equipment by the mechanical contractor, the TAB shall test and balance the system components to obtain optimum conditions in each conditioned space in the building. If construction deficiencies are encountered that preclude obtaining optimum conditions, and the deficiencies cannot be corrected by the Contractor within a reasonable period of time, the TAB shall proceed to other systems to test as available or cease testing and balancing services and advise the Owner and Engineer in writing of the deficiencies. TAB work shall be completed prior to Substantial Completion of the project.

D. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

E. TAB Agency Qualifications:

1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.

2. Having minimum of three years documented experience and six projects of like size and scope.

3. Certified by one of the following:

a. AABC, Associated Air Balance Council

b. NEBB, National Environmental Balancing Bureau

F. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

G. The TAB firm shall be capable of performing the services specified at the location of the facility described within the time specified, of preparing and submitting the detailed report of the actual field work performed, and following up on the basic work as may be required.

3.2 PROCEDURES FOR TESTING, ADJUSTING AND BALANCING EXISTING SYSTEMS

A. Perform a pre-construction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.

2. Measure the motor voltage and amperage. Compare the values to the motor nameplate information.

3. Check the refrigerant charge.

4. Check the condition of the filters.

5. Check the condition of the coils.

6. Check the operation of the drain pan and condensate drain pan trap.

7. Check bearings and other lubricated parts for proper lubrication.

8. Report on the operating conditions of the equipment and the results of the measurements taken. Identify deficiencies and provide report of all information to the Owner and Engineer.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that equipment has been cleaned and refurbished. Report any deficiencies to the Owner and Engineer.

1. New filters are installed.

2. Coils are clean and combed.

3. Drain pans are clean and draining.

4. Fans are clean.

5. Bearings and other parts are properly lubricated.

6. Deficiencies noted in the pre-construction report are corrected.

C. Perform and record air flow measurements of each supply fan, return fan, air system and air device in the project area prior to demolition and/or renovation.

1. Measure and record exhaust fan airflow, static pressure, voltage and amperage of each fan system including each air device inlet, fan inlet and outlet.

2. Measure and record airflow of each supply and return air device in the project area.

3. Measure and record airflow, inlet static pressures, outlet static pressures and static pressure drops across each component (coils, filters, dampers, etc.) of equipment serving the project area that is to remain in use.

D. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan speed, filter and coil face velocity.

2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by the equipment manufacturer.

3. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated and required airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.

4. Air balance each supply, return and exhaust air outlet and inlet.

5. Refer to the existing A/C system balance schedule on the drawings.

3.3 EXAMINATION

A. Contractor shall verify that systems are complete and operable before commencing balancing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.

2. Temperature control systems are installed complete and operable.

3. Proper thermal overload protection is in place for electrical equipment.

4. Air Distribution Systems:

a. All specified filters are clean and in place. Replace used/dirty filter media prior to TAB work being performed. If required, install temporary media in addition to final filters.

b. Duct systems are clean of debris.

c. Fans are rotating correctly, checked for proper belt tension, and are free from excessive noise and vibration at full load.

d. All supply, return, exhaust and transfer grilles, registers, diffusers, and terminal units with controls are installed. All air devices shall be clean externally and internally.

e. Rated dampers, motorized dampers, and manual volume dampers are in properly installed, clean, powered (where applicable), and open. Volume damper handles shall be exposed through insulation. Motorized dampers shall have unrestricted movement from full open to full closure. Control wiring to dampers shall be in place and operational. Should any device not be readily accessible, Contractor shall provide access as requested by the TAB firm.

f. Air coil fins are cleaned and not damaged. Damaged fins shall be combed or replaced prior to coil performance testing.

g. Blank off sections are installed at all filters and coils to eliminate excessive by-pass or leaking of air.

h. Access doors are closed and duct end caps are in place.

i. Air outlets are installed and connected.

j. Duct system leakage is minimized.

k. Supply, return, outside air, make-up air, and exhaust ductwork is terminated and pressure tested for leakage as required by specifications.

5. Automatic Controls:

a. Verify that control components are installed in accordance with project requirements and are functional, including electrical interlocks, damper sequences, air and water resets, fire and freezestats, temperature and humidity sensors, and high and low limit switches.

b. Verify that airflow and static pressure controllers/transmitters are installed and calibrated.

c. Verify that controlling instruments are calibrated and set for design operating conditions.

d. Verify variable frequency devices are adjusted in manual mode to allow drive to meet rated motor nameplate amps.

B. Notification of System Readiness

1. After completion of the work above, notify the TAB agent certifying that the work has been accomplished and that the building and the air conditioning systems are ready for testing, adjusting, and balancing.

2. Provide the TAB contractor all project drawings and specifications, addendum, approved revisions, RFI's, equipment submittal data, approved shop drawings, and equipment brochures as appropriate.

3. Report defects and deficiencies that will or could prevent proper system balance.

C. As part of bid, Contractor shall include costs necessary to make any changes in the sheaves, belts, dampers, and other devices required for correct balance as required by the TAB.

3.4 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.

1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Coordinate the installation of any additional balancing devices with the Contractor as required.

C. Complete readiness of the building requires that construction status of the building shall permit the closing of doors and windows and ceilings shall be installed to obtain projected operating conditions. Exterior doors shall remain closed during the balancing process of adjacent spaces and during building pressurization testing.

D. Provide and coordinate services of qualified, responsible trades, suppliers and personnel as required to correct, repair, adjust or replace any and all deficient items or conditions found during the testing, adjusting and balancing period.

E. Contractor shall operate said systems at his expense for the length of time necessary to complete the TAB process.

F. Project completion schedules shall provide sufficient time to permit the completion of TAB services prior to Owner occupancy.

3.5 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Terminal Units: Adjust total to within plus or minus 10 percent of design.

C. Air Valves: Adjust total to within plus or minus 5 percent of design.

D. Air Outlets and Inlets: Adjust total airflow to each space to within plus 10 percent and minus 5 percent of design. Adjust individual outlets and inlets in space to within plus or minus 10 percent of design.

3.6 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:

1. Running log of events and issues.

2. Discrepancies, deficient or uncompleted work by others.

3. Contract interpretation requests.

4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. During the TAB work, the temperature regulation shall be adjusted for proper relationship between controlling instruments. Advise Owner of any instruments out of calibration.

F. The TAB agent shall perform troubleshooting functions such as obtaining static pressure profiles, temperature and pressure readings, or additional traverses to assist in determining any system balancing problems. The TAB agent shall suggest solutions to any balancing problems to the Contractor and Engineer.

G. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

H. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats normal setpoints.

I. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner or Owner's Representative.

   1. If random tests demonstrate a measured flow deviation of 10 percent or more from that recorded in the certified TAB report, the report shall automatically be rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified TAB report submitted, and a new inspection test made, all at no additional cost to the Owner.

J. TAB firm shall provide for one callback request to retest any unresolved problems noted in the final report. The revised results shall be submitted after completion of the retesting.

K. Make one inspection within 90 days after occupancy of the building to insure that satisfactory conditions are being maintained throughout and to satisfy any unusual conditions. Prepare and submit a report stating the 90 day visit is completed and note any adjustments made.

3.7 OPPOSED SEASON TESTING

A. The balancing agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

B. During the opposed season testing, any necessary modifications to the initial adjustment required to produce optimum operation of the system components shall be made to produce the proper seasonal conditions in each conditioned space. At the time of opposed season checkout, give Owner timely notification before any readings or adjustments are made.

C. This service allows for testing of equipment that, due to extreme weather conditions, cannot be accurately tested at the time of the initial balance. If a project is balanced during

the summer, the opposed season test is performed during the winter months and vice-versa.

D. Submit updated final report with a summary of the system modifications made and updated setpoints.

3.8 AIR SYSTEM PROCEDURE

A. Supply Air:

1. Fans checked for proper rotation, measure and record motor amperage, fan differential pressure, and RPM. Measure and record supply outlets prior to fan or damper adjustments.

2. Make total airflow quantity measurements in ducts by pitot tube traverse of entire cross sectional area of duct. If a pitot tube traverse is not practical, the summation of the outlet's may be used. An explanation why a traverse was not made must be presented on the appropriate data sheet.

3. Measure and adjust airflow quantities at air outlets within specified tolerance. Use branch ductwork dampers to proportion airflow in the system and to minimize the amount of volume regulation required at the manual damper nearest each air outlets.

4. Identify system leakage through traverse and outlet summation for each system. If traverse quantities and outlet summations differ by more than 10 percent, then an explanation must be presented with appropriate recommendations.

5. Report traverse and outlet totals compared to reading from airflow measuring stations where present. If necessary, coordinate the recalibration of the airflow transmitted to insure proper operation of the control functions. Coordinate with the temperature control vendor to insure traverse and airflow station readings are in agreement.

6. Note any objectionable noise created by dampers or diffusers.

7. Make sheave adjustments/changes as necessary to provide design airflow.

8. Provide system schematic with required and actual air quantities recorded at each outlet.

9. Measure static air pressure on air handling units, including filter and coil pressure drops, and total pressure across the fan.

10. Record any notable leakage or damaged/missing gaskets across outside air, return air, and relief air dampers and/or unit access doors.

B. Return Air:

1. Fans checked for proper rotation, measure and record motor amperage, fan differential pressure, and RPM. Measure and record return inlets prior to fan or damper adjustments.

2. With supply system in the maximum mode, traverse and adjust return fan to design maximum CFM. Measure and adjust airflow quantities at air inlets within specified tolerance. Use branch ductwork dampers to proportion airflow in the system and to minimize the amount of volume regulation required at the manual damper nearest each air inlet.

3. Identify system leakage through traverse and inlet summation for each system. If traverse quantities and inlet summations differ by more than 10 percent, then an explanation must be presented with appropriate recommendations.

4. Report traverse and inlet totals compared to reading from airflow measuring stations were present. If necessary, coordinate the recalibration of the airflow transmitted to insure proper operation of the control functions. Coordinate with the temperature control vendor to insure traverse and airflow station readings are in agreement.

5. Note any objectionable noise created by dampers or diffusers.

C. Outside Air:

1. With supply system in the design maximum mode, adjust minimum outside air damper to obtain design airflow rate through pitot tube traverse. Measure and record traverse and static pressure. 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 temperatures. Make allowances for heat of compression and motor heat where applicable. Record all temperatures.

2. After completion, take total air handling unit static profile and record all final static pressure, motor amperage, RPM, and CFM.

D. Exhaust Air:

1. Fans checked for rotation, measure and record motor amperage, fan differential pressure, and RPM. Measure and record exhaust inlets prior to fan or damper adjustment.

2. Insure backdraft damper is open and has free operation.

3. Perform pitot tube traverse, adjust fan speed, and proportion main branch lines.

4. Balance inlets within specified tolerance. Use branch ductwork dampers to proportion airflow in the system and to minimize the amount of volume regulation required at the manual damper nearest each air inlet.

5. Measure and record final total exhaust air through a pitot tube traverse and record static pressure and flow at traverse point.

6. Identify system leakage through traverse and inlet summation. If traverse quantities and inlet summations differ by more than 5 percent, then an explanation must be presented with appropriate recommendations.

7. Note any objectionable noise created by dampers or diffusers.

E. Duct Mounted Smoke Detectors:

1. Measure and record pressure differential across intake and exhaust tubes. Pressure differential must be within manufacturer's recommendation for specific duct velocity.

2. Report pressure differential for each duct mounted smoke detector in final TAB report.

3.9 WATER SYSTEM PROCEDURE

A. Controls:

1. AHU Controls:

a. TAB shall notify Contractor and Engineer of any control device not properly installed, calibrated or functioning to meet the full intent of the Contract Documents.

b. For DDC systems, the TAB shall work closely with the controls supplier to verify calibration of all control, sensing and measuring devices. Actual measurements at devices shall match readouts at the FMS computer.

c. Check temperature controls for proper calibration and setpoint. Record final temperatures.

d. Check economizer controls for proper damper operation and control calibration (outside air conditions may preclude actual calibration test).

e. Check and test calibration of the supply/return volumetric synchronization system. Check differential setpoint between supply and return fan volumes to insure design outside air is introduced into system.

f. Determine system static pressure set points and coordinate with controls supplier.

g. Check static pressure control, under maximum and minimum conditions, for proper operation.

h. Determine and adjust high limit fan discharge static pressure switch; coordinate set point with controls supplier.

2. Thermostats and Controllers:

a. Check for proper control of valves, air terminal units, supply fans, exhaust fans, ventilation fans, unit heaters, radiant heaters, and air curtains.

b. Determine calibration setpoint of all thermostats.

c. Set at design setpoint, unless noted or directed otherwise.

B. Capacity and Performance Test

1. Cooling Coils:

a. Measure and record entering and leaving dry and wet bulb air temperatures with glass stem, mercury thermometers accurate to 1/4 degrees F.

b. Record final air and water temperatures, BTU/HR and GPM.

c. Convert actual test condition to design entering temperatures to insure design coil capacities at design temperatures. (Winter test may have entering temperatures too extreme to accurately convert to design summer loads).

2. Heating Coils (Air Handling Unit and Preheat Only):

a. Measure and record entering and leaving dry bulb temperature with glass stem, mercury thermometers accurate to 1/2 degree F.

b. Compute BTU/HR and GPM from heat transfer test.

c. Record final and water temperatures, BTU/HR and GPM.

d. Convert actual test conditions to design entering temperatures to insure design coil capacities at design temperatures. (Summer temperatures may have entering temperatures too extreme to accurately covert to winter loads.)

3. Thermostat Calibration:

a. Measure and record dry and wet bulb temperatures at each thermostat.

b. Note any thermostat which is not controlling with +/- 1-1/2 degree F.

4. Control Temperature Readouts:

a. Test actual temperature next to sensing bulb (if possible) and compare to read-out gauge. BAS readout.

b. Report any gauge out of calibration.

C. Domestic Hot Water:

1. Check system for cleanliness including pump strainer(s).

2. Record initial pump GPM and total dead head.

3. Balance recirculating pumps within specified tolerance. Pumps arranged in a parallel configuration for redundancy shall be tested and balanced separately. Measure and

record final pump suction and discharge pressures, motor voltage, amps, and nameplate data.

4. Measure and set all system balancing valves within specified tolerance. Record final settings including GPM, position of indicator, and measured pressure drop. Permanently mark settings of balancing valves.

5. Test and record pressure drops and temperature drops through heat exchangers and boilers. Calculate and record GPM.

6. Balance primary hot water pumps at boilers within specified tolerance. Measure and record final pump suction and discharge pressures, motor voltage, amps, and nameplate data.

7. Measure and record mixing valve hot, cold, and tempered water temperatures and pressures.

3.10 HVAC DUCTWORK PRESSURE TESTING

A. The TAB agent shall perform HVAC ductwork pressure testing as specified in Section 23 31 13 - Sheetmetal Ductwork.

3.11 MINIMUM DATA TO BE REPORTED

A. Electric Motors (record along with information listed under associated equipment, as applicable):

1. Manufacturer.

2. Model/Frame.

3. HP/BHP.

4. Phase, voltage, amperage; nameplate & operating

5. RPM.

6. Service factor.

7. Starter size, rating, heater elements.

8. Sheave Make/Size/Bore.

B. Belt Drives (record along with information listed under associated equipment, as applicable):

1. Identification/location.

2. Required driven RPM.

3. Driven sheave, diameter and RPM.

4. Belt manufacturer, size and quantity
5. Motor sheave diameter and RPM.
6. Center to center distance, maximum, minimum, and actual.

C. Air Cooled Condensers:

1. Identification/number.
2. Location.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Entering DB air temperature, design and actual.
7. Leaving DB air temperature, design and actual.
8. Number of compressors, refrigerant suction/discharge pressures
9. Refrigerant type

D. Cooling Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Rows and fins/inch, design and actual
6. Air flow, design and actual.
7. Entering air DB temperature, design and actual.
8. Entering air WB temperature, design and actual.
9. Leaving air DB temperature, design and actual.
10. Leaving air WB temperature, design and actual.
11. Water flow, design and actual.
12. Water pressure drop, design and actual.
13. Entering water temperature, design and actual.

14. Leaving water temperature, design and actual.

15. Saturated suction temperature, design and actual.

16. Air pressure drop, design and actual.

E. Heating Coils and ATU Reheat Coils:

1. Identification/number.

2. Location.

3. Service.

4. Manufacturer.

5. Rows and fins/inch, design and actual

6. Air flow, design and actual.

7. Water flow, design and actual.

8. Water pressure drop, design and actual.

9. Entering water temperature, design and actual.

10. Leaving water temperature, design and actual.

11. Entering air temperature, design and actual.

12. Leaving air temperature, design and actual.

13. Air pressure drop, design and actual.

F. Air Moving Equipment:

1. Location.

2. Manufacturer.

3. Model number.

4. Serial number.

5. Arrangement/Class/Discharge.

6. Air flow, specified and actual.

7. Return air flow, specified and actual.

8. Outside air flow, specified and actual.

9. Static pressure profile across each component

10. Total static pressure (total external), specified and actual.

11. Inlet pressure.

12. Discharge pressure.

13. Filter type, MERV rating, sizes, and quantity

14. Filter differential pressure

G. Return Air/Outside Air:

1. Identification/location.

2. Design air flow.

3. Actual air flow.

4. Design return air flow.

5. Actual return air flow.

6. Design outside air flow.

7. Actual outside air flow.

8. Return air temperature.

9. Outside air temperature.

10. Required mixed air temperature.

11. Actual mixed air temperature.

12. Design outside/return air ratio.

13. Actual outside/return air ratio.

H. Exhaust Fans:

1. Location.

2. Manufacturer.

3. Model number.

4. Serial number.

5. Air flow, specified and actual.

6. Total static pressure (total external), specified and actual.

7. Inlet pressure.

8. Discharge pressure.

I. Duct Traverses:

1. System zone/branch.
2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.
9. Air temperature.
10. Air correction factor.

J. Duct Leak Tests:

1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus:
   a. Blower.
   b. Orifice, tube size.
   c. Orifice size.
   d. Calibrated.
7. Test static pressure.
8. Test orifice differential pressure.
9. Leakage.

K. Air Monitoring Stations:

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

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Insulation requirements for following systems:

1. Ductwork and plenums
2. Split system air conditioning equipment

1.2 RELATED REQUIREMENTS

A. Section 23 05 53 - Identification for HVAC Piping and Equipment

B. Section 23 21 13 - HVAC Piping

C. Section 23 21 16 - Hydronic Piping Specialties

D. Section 23 23 00 - Refrigerant Piping System

E. Section 23 31 13 - Sheet metal Ductwork

F. Section 23 31 14 - Sheet metal - Special Ductwork

1.3 DEFINITIONS

A. Exposed - Equipment, ducts and piping in areas which will be visible without removing ceilings or opening access panels.

B. Concealed - Installed above ceiling, in walls or chases.

C. Outdoors - Exposed to the weather or ambient conditions.

D. Underground - Buried.

1.4 REFERENCE STANDARDS

A. ASTM C553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.

B. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2012.

C. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2011.

D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2013.

E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2012.

F. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2013.

G. SMACNA (DCS) - HVAC Duct Construction Standards; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

1.5 SUBMITTALS

A. Provide product data and required information under the provisions of Division 01.

B. Submit manufacturer's product data and installation procedures for review. Product data shall identify specific thermal characteristics, list of materials and thickness for each service.

1.6 QUALITY ASSURANCE

A. Fire-Test Response Characteristics: Testing in accordance with ASTM E84. Insulation and related materials, adhesives, coatings, sealers, jackets and tapes, shall have a fire-test response characteristic of: Flame spread rating of 25 or less; Smoke development of 50 or less. If a product complies with ASTM E84 only in limited thickness, provide only those sizes which comply and use multiple layers as required to get required thickness.

B. Materials shall meet the requirements of NFPA 90A.

PART 2 - PRODUCTS

2.1 PIPE AND EQUIPMENT INSULATION MATERIALS

A. Materials for Pipe and Equipment: Provide factory premolded insulation for pipe, pipe fittings, and valves.

B. Fitting insulation: Same thickness and material as adjoining pipe insulation.

C. Cellular Glass (Foamglas):

1. Acceptable manufacturers: Pittsburgh Corning "Foamglas"; with a "K" value of 0.29 BTU-in/hr-ft2-degree F at 75 degrees F.

2. Mastic: Water based, Foster 30-80 or equal

a. Outside Applications: Foster Vapor Safe 30-80, Childers Chil Low CP-38 or Vimasco 749 Vapor-Blok. Coatings must meet MIL 19565C and be QPD listed. Water vapor permeance shall be in accordance with ASTM C755, section 7.2.2 and Table 2 for insulation type and service conditions when tested in accordance with ASTM E96.

b. Inside applications: Foster Vapor Safe 30-80, Childers Chil Low CP-38 or Vimasco 749 Vapor-Blok. Water vapor permeance shall be in accordance with ASTM C755, section 7.2.2 and Table 2 for insulation type and service conditions

when tested in accordance with ASTM E96, with a maximum Perm rating of 0.02.

D. Flexible Tubular Elastomeric:

1. Provide fire-retardant closed-cell slip-on flexible type; with a "K" value of 0.245 BTU-in/hr-ft2-degree F at 75 degrees F.

2. Acceptable manufacturers: Aeroflex "Aerocel", Armacell "AP/Armaflex", or K-Flex "Insul-Tube".

E. Flexible Sheet Elastomeric:

1. Provide closed-cell flexible sheet type; minimum "R" value of 4.20 per inch of thickness.

2. Acceptable manufacturers: Aeroflex, Armacell "AP/Armaflex", or Rubatex.

F. Jackets and Coverings:

1. Canvas Jacket: UL listed 6oz/sq. yd. plain weave cotton fabric treated with dilute fire retardant lagging adhesive compatible with insulation.

2. Aluminum Jacket: ASTM B209 formed aluminum sheet of 0.016 inch, smooth finish with longitudinal slip joints and 2" laps, 0.016" think die shaped fittings with factory attached protective liner. Adhere with 3/8" inch wide aluminum bands.

3. PVC Jacket: One piece molded type fitting covers and sheet material, off-white in color, 15 mil thickness, 0.002 per inch maximum in accordance with ASTM E96. Adhere with pressure sensitive color matching vinyl tape.

2.2 PIPE AND EQUIPMENT INSULATION - SYSTEMS AND EQUIPMENT

A. General:

1. Where multiple materials are listed for a system, any of the materials may be used.

B. Split system air conditioning equipment piping: flexible tubular elastomeric 1.5" thick

2.3 DUCTWORK INSULATION

A. Blanket Type Duct Insulation:

1. Acceptable manufacturers: CertainTeed, Johns-Manville, Knauf, or Owens Corning.

2. Provide with Foil Reinforced Kraft (FSK) vapor barrier with a maximum Perm rating of 0.02 or less, providing the minimum "R" value and pound per cubic foot (PCF) density shown below.

3. Use on the following:

a. Unlined supply air ductwork in an unconditioned space, including concealed above ceiling: 2.2", 0.75 PCF, installed "R" value of 6.0.

b. Unlined, exposed supply air ductwork: 2.2", 0.75 PCF, installed "R" value of 6.0.

1) Insulation may be omitted from exposed low pressure supply air ductwork in area served by the ductwork, except where the exposed ductwork is in rooms with doors/openings to the exterior

2) Where the exposed ductwork is in rooms with doors/openings to the exterior, provide internal liner insulation where duct is below 7 ft above finished floor or other areas where duct can be easily damaged.

c. Unlined make-up air ductwork: 1.5", 0.75 PCF, installed "R" value of 4.2.

d. Unlined ductwork supplying untreated outside air: 2.2", 0.75 PCF, installed "R" value of 6.0.

e. Unlined return air ductwork installed in the following locations, using 2.2", 0.75 PCF, installed "R" value of 6.0.

f. Concealed above ceiling, with roof directly above ceiling

g. Unlined exhaust air ductwork installed in the following locations, using 1.5", 0.75 PCF, installed "R" value of 4.2.

1) Unvented attic above ceiling insulation

h. Reheat coils, including reheat coils at terminal boxes: 2.2", 0.75 PCF, installed "R" value of 6.0.

i. Slot diffuser supply air plenums not internally lined: 2.2", 0.75 PCF, installed "R" value of 6.0.

j. Unlined ductwork supplying combustion air to condensing boilers: 1-1/2" thick, 0.75 PCF, installed "R" value of 4.2.

k. Exterior ductwork: Provide minimum R-8 insulation in ASHRAE Climate Zones 1 through 4 and minimum R-12 insulation in ASHRAE Climate Zones 5 through 8.

B. Board Type Duct Insulation:

1. Acceptable manufacturers: CertainTeed IB-300, Johns-Manville, Knauf, or Owens Corning.

2. Provide semi-rigid glass fiber board type insulation with Foil Reinforced Kraft (FSK) vapor barrier having a minimum "R" value and pound per cubic foot (PCF) density shown below.

3. Use on the following services:

   a. Unlined, exposed supply and return ductwork in areas such as loading docks and areas with openings to the exterior: 1.5", 3.00 PCF, "R" value of 6.5.

   b. Unlined, exposed exhaust ductwork in areas such as loading docks and areas with openings to the exterior: 1", 3.00 PCF, "R" value of 4.3.

   c. Unlined return air ductwork within equipment rooms: 1.5", 3.00 PCF, "R" value of 6.5.

   d. Unlined relief air ductwork within equipment rooms: 1.5", 3.00 PCF, "R" value of 6.5.

   e. Relief and exhaust plenums: 1.5", 3.00 PCF, "R" value of 6.5.

   f. Exterior, outside ductwork, supply and return: 2.0", 3.00 PCF, "R" value of 8.7. Provide minimum R-8 insulation in ASHRAE Climate Zones 1 through 4 and minimum R-12 insulation in Climate Zones 5 through 8.

   g. Exterior, outside ductwork, exhaust and relief: 1", 3.00 PCF, "R" value of 4.3.

   h. Outside air intake plenums: 1.5", 3.00 PCF, "R" value of 6.5.

C. Duct Insulation Sealants:

1. All duct insulation vapor barrier sealants and mastics shall be water based, low VOC with a maximum perm rating of 0.02 or less; Design Polymerics 3040 or equal.

2. Foil tape is not acceptable.

2.4 MATERIALS FOR FITTINGS, VALVES, AND SPECIAL COVERINGS

A. For all services, use full thickness premolded insulation for pipe fittings, elbows, tees, valves, and couplings 2-1/2 and larger. Finish shall be as specified under Products above or as specified below. PVC fitting covers may be used over the premolded insulation for chilled water and heating water systems.

B. PVC fitting covers with full thickness fiberglass inserts may be used on piping fittings elbows and valves 2" and less for chilled water and heating water systems.

C. For pipe fittings, valves, strainers, and other irregular surfaces, in chilled water or refrigerant systems operating below 60 degrees F, when inside building or in equipment rooms, cover insulation with white colored woven glass fabric embedded in white vapor barrier coating, Foster 30-35 or equal.

D. Elastomeric adhesives and finishing:

1. Adhesive shall be the insulation manufacturer's recommended contact adhesive, Armaflex 520, Armaflex 520BLV or equivalent.

2. Insulation finish shall be the insulation manufacturer's recommended finish--WB Armaflex finish and shall be paintable.

3. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and not detract from any of the system ratings as specified.

4. Where exposed to view inside buildings, the painted finish color shall be as selected by the Architect.

E. For externally insulated sheet metal ducts when above grade exposed-to-the-weather outside building, slope ductwork and insulation to allow drainage and prevent ponding of water on top of ductwork. Cover duct insulation with weather-proof cladding equal to Alumaguard with following features:

1. Composite membrane cladding, UV resistant aluminum foil/polymer laminate outer cover

2. Rubberized asphalt inner layer, that self-seals punctures and is self-adhesive to duct insulation

3. 54 mil thickness, 0.00 water transmission per ASTM E96-00, 0.00 water permeance per ASTM E96-00.

F. Use prefabricated removable insulated, valve jackets on all valves in steam and steam condensate piping. Insulated jackets shall cover the entire valve including flanges and bonnet.

1. Acceptable manufacturers: Auburn Manufacturing, Inc. (AMI) or ThermaXX.

2. Inner lining: AMI GL2025-XX-9383 heat treated fiberglass cloth (<450F).

3. Insulating material: AMI AM1000 needled fiberglass mat (<1000F).

4. Outer cover: AMI AGL2025 aluminum foil laminated fiberglass cloth.

5. Fastener: AMI GLR fiberglass draw string.

G. Use prefabricated removable insulated, custom fit covers for chilled water pump casings.

1. Acceptable manufacturers: Fit Tight Covers or approved equal

H. Do not insulate valve stems.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Deliver and store insulation materials in manufacturers containers and keep free from dirt, water, chemical and mechanical damage.

B. Complete piping and ductwork pressure testing prior to applying insulation.

C. Apply insulation in workmanlike manner by experienced, qualified, workmen.

D. Do not install duct sealants on systems that are operating. Follow manufacturers written instructions for proper cure times.

E. Surfaces shall be clean and dry when covering is applied. Covering to be dry when installed and before and during application of any finish, unless such finish specifically requires a wetted surface for application.

F. Adhesives, cements and mastics shall be compatible with materials applied and shall not attack materials in either wet or dry state and not diminish or void the specified flame spread and smoke developed ratings.

G. Stop duct coverings, including jacket and insulation, at fire penetrations of fire or smoke rated partitions, floors above grade and roofs. "Fan-out" or extend jacketed insulation at least 2" beyond angle frames of fire dampers and secure to wall. Maintain vapor barrier.

3.2 BLANKET TYPE DUCT INSULATION

A. Apply jacketed blanket type glass fiber covering to ducts pulled snug but not so tight as to compress corners more than 1/4". Use insulation having 2" tab, or cut insulation long enough to allow for "peel-off" of insulation from jacket to effect a minimum overlap of 2". Staple lap with flare type staples on 1" centers. Cover standing seams, stiffeners, and braces with same insulation blanket, using 2" jacket lap and staple lap as herein before outlined. Cover and seal all staples with Foster 30-80 reinforced with glass cloth. Do not use pressure sensitive tape.

B. Secure jacket to covering using equivalent of Foster No. 85-20 or Childers CP-82 adhesive.

C. For ducts 24" or wider, mechanically fasten insulation to duct bottom, using weld or adhesive pins having self-locking, metal discs, locating fasteners on not over 12" centers laterally and longitudinally. Seal pins as above.

D. For ducts up to 24" deep, mechanically fasten insulation to duct sides, using one row of pins, plates or discs located on not over 12" centers longitudinally and equidistant laterally between duct top and bottom. For ducts 24" deep and greater, apply fasteners as before only using minimum of two rows.

3.3 BOARD TYPE DUCT INSULATION

A. Apply jacketed board type glass fiber covering to ducts using weld or adhesive pins having self-locking coated metal or nylon discs; locate fasteners on not over 12" centers laterally and longitudinally. If insulation is grooved to fit around corners, in order to eliminate as many joints as possible, pin as required to hold insulation tight to duct, especially on bottom of duct. Seal pins and joints with Foster 30-80 reinforced with glass cloth.

B. Cover all joints, rips, tears, punctures, disc heads, staples, or breaks in vapor barrier jacket with 4" wide woven glass fabric tape embedded in equivalent of Foster 30-80 vapor barrier, fire resistant adhesive. Do not use pressure sensitive tape.

3.4 DUCT AND PLENUM LINER APPLICATION:

A. Adhere insulation with adhesive for 100 percent coverage.

B. Secure insulation with mechanical liner fasteners. Refer to SMACNA HVAC Duct Construction Standards for spacing.

C. Seal and smooth joints. Seal and coat transverse joints.

D. Seal liner surface penetrations with adhesive.

E. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

END OF SECTION 23 07 00

SECTION 23 09 13
INSTRUMENTATION AND CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Input and output control devices to integrate with direct digital control and building automation system.

B. Furnish instrumentation control devices as an integral part of the Building Automation Section specified in Section 23 09 23 - Direct-Digital Control System for HVAC.

1.2 RELATED REQUIREMENTS

A. Section 23 05 00 - Common Work Results for HVAC

B. Section 23 09 23 - Direct-Digital Control System for HVAC

C. Section 23 20 00 - HVAC Piping

D. Section 23 31 13 - Sheetmetal Ductwork

E. Section 23 36 00 - Air Terminal Units

F. Division 26: Electrical

1.3 SUBMITTALS

A. Submit product data and schedules for all input/output devices in accordance with the requirements of Division 01.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide products and components by manufacturers listed. Where manufacturers are not listed, provide component that complies with specifications.

B. Manufacturers listed must meet performance and material specifications of product or component. Listing of a manufacturer as an acceptable manufacturer does not grant permission to deviate from the specification requirements.

C. All airflow-measurement stations shall bear the AMCA Certified Ratings Program seal for Air Performance.

2.2 INPUT DEVICES

A. General Requirements

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

1. Acceptable Manufacturers: Automated Logic, Johnson Controls, Setra, or Siemens.

   a. Substitutions: Refer to Division 01.

2. General Requirements:

   a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

   b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

   c. Accuracy values indicated include errors associated with the sensor, lead wire, and analog to digital conversion.

3. Room Temperature Sensors

   a. Refer to temperature sensor legend, schedules, floor plans, and control sequences for specific room temperature sensor requirements in each zone.

   b. Room sensors shall be constructed for either surface or wall box mounting.

   c. Room sensors shall have the following options when specified:

      1) Local setpoint adjustment providing a +/- 3 degree (adjustable) range.

      2) Timed override request push button with LED status for activation of after-hours operation.

      3) Flush mounting (sensor only, no local adjustment)

      4) Integral LCD display and keypad with the following capabilities:

         (a) Display room and outside air temperatures.

         (b) Display room setpoint.

         (c) Password selectable adjustment of setpoint and override modes.

4. Stand Alone Thermostats

   a. Stand alone, heavy-duty electric thermostats shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, when equipment is not indicated to be connected to the BAS. Thermostats shall be provided with concealed adjustment and function to cycle the equipment fan, electric coil, and/or control valves as applicable to maintain the space temperature setpoint. Finish of covers for all

room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

5. Thermo Wells

   a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.

   b. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.

   c. Thermo wells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.

   d. Thermo wells shall be constructed of 316 stainless steel.

6. Outside Air Sensors

   a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

   b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.

   c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

7. Duct Mount Sensors

   a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

   b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

   c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

8. Averaging Sensors

   a. Provide at the following locations:

      1) Heating coils and cooling coils at air handling units and fan coil units.

      2) Ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists.

   b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification

and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.

c. Capillary supports at the sides of the duct shall be provided to support the sensing string.

9. Low Limit Temperature Sensors

a. Provide vapor charged sensing element that reacts to coldest 14" of sensor length.

b. Sensor shall have field adjustable setpoint.

C. Humidity Sensors

1. Acceptable Manufacturers: Johnson Controls, Mamac, or Veris Industries.

a. Substitutions: Refer to Division 01.

2. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.

3. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

4. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.

5. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.

6. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

7. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

D. Differential Pressure Transmitters

1. Acceptable Manufacturers: Automated Logic, Johnson Controls, Mamac, Setra, or Siemens.

a. Substitutions: Refer to Division 01.

2. General Air and Water Pressure Transmitter Requirements:

a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.

c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.

d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

3. Building Differential Air Pressure Applications (-1" to +1" w.c.)

a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

1) -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)

2) 4-20 mA output.

3) Maintain accuracy up to 20 to 1 ratio turndown.

4) Reference Accuracy: +0.2% of full span.

4. Building Low Range Differential Air Pressure Applications (0" to 5" w.c.)

a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

1) (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)

2) 4-20 mA output.

3) Maintain accuracy up to 20 to 1 ratio turndown.

4) Reference Accuracy: +0.2% of full span.

5. Building Medium Range Differential Air Pressure Applications (5" to 21" w.c.)

a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:

1) Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.

2) Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.

3) Thermal Effects: <+.033 F.S./Deg. F. over 40 Deg. F. to 100 Deg. F. (calibrated at 70 Deg. F.).

b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

E. Air Flow Measuring Stations

1. Piezo Ring Air Flow Measuring Stations

a. Acceptable manufacturers: Air Monitor Corporation, Dietrich Standard, Paragon Controls, or Tek-Air.

1) Substitutions: Refer to Division 01.

b. At the inlet of each fan and near the exit of the inlet sound trap, flow measurement device shall be provided that shall continuously monitor the fan air volumes and system velocity pressure.

c. Flow measurement device shall consist of a Piezo ring mounted on the circumference of the fan inlet throat and an inlet tap mounted on the face of the inlet cone.

d. For multiple fans in parallel, provide Piezo ring/pressure tap at each fan inlet and provide an air flow totalizing panel equal to Paragon FAATS-1000 Fan Array Air Flow Totalizing system. The panel shall communicate the air flow of each individual fan and the total fan array air flow to the BAS. Air flow discrepancies and fan failures shall be alarmed from the panel to the BAS.

e. Station shall have an accuracy within +/- 5% of actual air flow and be rated for operation from 200 to 8,000 feet/minute velocity at up to 350 deg. F.

f. Station shall not induce a pressure drop greater than 0.15" w.c. at 4,000 feet/minute regardless of fan inlet size.

g. Station shall be anodized aluminum unless noted otherwise and built in accordance with ASHRAE Standard #111 and AMCA Publication #203.

2. Pitot Tube Fan Inlet Air Flow Measuring Stations

a. Acceptable manufacturers: Air Monitor Corporation, Dietrich Standard, or Paragon Controls.

1) Substitutions: Refer to Division 01.

b. Basis of Design: Air Monitor Corporation. The flow station and transmitter shall be by the same manufacturer.

1) Flow Station: VOLU-probe/FI

2) Transmitter: VEL-trol II

c. Flow Station

1) The air flow measuring station shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probes and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system air flows.

2) The air flow measuring station shall have symmetrical averaging signal takeoffs, and shall be of aluminum construction with hard anodized finish with galvanized steel mounting hardware.

3) The air flow measuring station shall not significantly impact fan performance or contribute to fan generated noise levels. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.

d. Transmitter

1) The transmitter-controller shall be capable of receiving flow signals (total and static pressure) from an air flow station or probe array and produce an output linear and scaled for air volume, velocity, differential pressure, etc. The internal P, I, I/D three-mode controller shall be capable of

controlling at a user selectable internal or external setpoint, and output a 0-5V DC, 0-10V DC, or 4-20mA DC control signal.

2) The transmitter-controller shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output plus controller setpoint during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons.

3) The transmitter-controller will be available in multiple natural spans covering the range of 0.05 in. w.c. to 10.0 in. w.c. with an accuracy of 0.10% of natural span. The transmitter-controller shall be furnished with a transducer automatic zeroing circuit, and be capable of maintaining linear output signals on applications requiring 10 to 1 velocity or pressure turndown.

4) Transmitter-controller shall be capable of having its operating span electronically selected without having to perform recalibration involving an external pressure source.

3. Pitot Tube Ductwork Air Flow Measuring Stations

a. Acceptable manufacturers: Air Monitor Corporation, Dietrich Standard, or Paragon Controls.

1) Substitutions: Refer to Division 01.

b. Basis of Design: Air Monitor Corporation. Coordinate monitor type with manufacturer and specific installation conditions. The flow station and transmitter shall be by the same manufacturer.

1) Flow Station: VOLU-probe

2) Transmitter: VEL-trol II

c. Flow Station

1) Each air flow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s), and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The air flow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30º. Each air flow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket, and signal fittings suitable for HVAC duct installation.

2) Total and static pressure sensors shall be located at the centers of equal areas (for rectangular ducts) or at equal concentric area centers (for circular ducts) along the probe length.

3) Probes shall be AMCA certified and be capable of measuring the air flow rates within an accuracy of ±2% without the use of correction factors. The maximum allowable unrecovered pressure drop caused by the probes shall not exceed 0.025" w.c. at 2000 FPM, or 0.085" w.c. at 4000 FPM

d. Transmitter

1) The transmitter-controller shall be capable of receiving flow signals (total and static pressure) from an air flow station or probe array and produce an output linear and scaled for air volume, velocity, differential pressure, etc. The internal P, I, I/D three-mode controller shall be capable of controlling at a user selectable internal or external setpoint, and output a 0-5V DC, 0-10V DC, or 4-20mA DC control signal.

2) The transmitter-controller shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output plus controller setpoint during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons.

3) The transmitter-controller will be available in multiple natural spans covering the range of 0.05 in. w.c. to 10.0 in. w.c. with an accuracy of 0.10% of natural span. The transmitter-controller shall be furnished with a transducer automatic zeroing circuit, and be capable of maintaining linear output signals on applications requiring 10 to 1 velocity or pressure turndown.

4) Transmitter-controller shall be capable of having its operating span electronically selected without having to perform recalibration involving an external pressure source.

4. Pitot Array Duct Air Flow Measuring Stations

a. Acceptable manufacturers: Air Monitor Corporation, Dietrich Standard, or Paragon Controls.

1) Substitutions: Refer to Division 01.

b. Basis of Design: Air Monitor Corporation. Coordinate monitor type with manufacturer and specific installation conditions. The flow station and transmitter shall be by the same manufacturer.

c. All air flow measurement stations shall bear the AMCA Certified Ratings Program seal for Air Performance.

1) Flow Station:

(a) Fan-Evaluator where short length of straight duct is present.

(b) VOLU-probe/VS where adequate length of straight duct is present.

2) Transmitter: VEL-trol II

d. Flow Station

1) Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.

2) Each air flow measuring station shall contain multiple total and static pressure sensors. Rectangular stations having a cross-section greater than 4 square feet shall have a minimum of 25 points of measurement. For stations having a dimension less than 18", locate the points of measurement at the center of equal areas not more than 6" apart, and use a minimum of two measurement points per side. For a station having a dimension greater than 56", the maximum distance between measurement points shall be 8". For circular ducts having a diameter of 18" or greater, locate measurement points on three systematically disposed diameters. For round stations smaller than 18", locate the measurement points on two perpendicular diameters.

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

4) Stations shall be AMCA certified and be capable of measuring the air flow rates within an accuracy of ±2%.

5) Pressure loss

(a) With straightener, the maximum allowable unrecovered pressure drop caused by the station shall not exceed 0.085" w.c. at 2000 FPM, or 0.30" w.c. at 4000 FPM.

(b) Without straightener, the maximum allowable unrecovered pressure drop caused by the station shall not exceed 0.025" w.c. at 2000 FPM, or 0.085" w.c. at 4000 FPM.

e. Transmitter

1) The transmitter-controller shall be capable of receiving flow signals (total and static pressure) from an air flow station or probe array and produce an output linear and scaled for air volume, velocity, differential pressure, etc. The internal P, I, I/D three-mode controller shall be capable of controlling at a user selectable internal or external setpoint, and output a 0-5V DC, 0-10V DC, or 4-20mA DC control signal.

2) The transmitter-controller shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output plus controller setpoint during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons.

3) The transmitter-controller will be available in multiple natural spans covering the range of 0.05 in. w.c. to 10.0 in. w.c. with an accuracy of 0.10% of natural span. The transmitter-controller shall be furnished with a transducer automatic zeroing circuit, and be capable of maintaining linear output signals on applications requiring 10 to 1 velocity or pressure turndown.

4) Transmitter-controller shall be capable of having its operating span electronically selected without having to perform recalibration involving an external pressure source.

5. Thermal Dispersion Air Flow/Temperature Measurement Devices

a. Acceptable manufacturers: Air Monitor Corporation, Ebtron, or Johnson Controls.

1) Substitutions: Refer to Division 01.

2) Vortex shedding, pitot tubes, pitot arrays, or piezo ring monitors are not acceptable.

b. Basis of Design:

1) Single or DWDI Fans: Ebtron Model HTA-104

2) Fan walls: Ebtron Model GTx108-F

3) Duct/plenum mounted: Ebtron Model GTx116-P+

c. Provide air flow/temperature measurement devices (AFMS) where indicated on the plans.

d. Each AFMS shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor nodes contained in one or more probe assemblies per measurement location.

1) Each sensor node shall contain two individually wired, hermetically sealed bead-in-glass thermistors.

2) Thermistors shall be mounted in the sensor node using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment. Thermistor leads shall not be fastened to the thermistor semiconductor substrate by weld or solder connections.

3) The air flow rate at each sensor node shall be equally weighted and arithmetically averaged by the transmitter prior to output. All integrated circuitry shall be temperature rated as 'industrial-grade'. Submissions containing 'commercial-grade' integrated circuitry are not acceptable.

4) The temperature at each sensor node shall be arithmetically averaged or velocity weighted and averaged by the transmitter prior to output, either as field-selected by the contractor or user.

5) Each transmitter shall have a 16-character alpha-numeric display capable of displaying air flow, temperature, system status, configuration settings and diagnostics.

6) Other than the thermistor sensors, no other electronic components shall be located at the sensing node.

7) Devices using chip-in-glass, epoxy-coated or diode-case chip thermistors are not acceptable.

8) Devices with RJ-45 connections exposed to the environment or having electronic circuitry mounted in or at the sensor node are not acceptable.

e. All Sensor Probes

1) Each sensor node, consisting of two thermistor-sensors and their structural housing, shall independently determine the air flow rate and temperature at each measurement point.

2) Each sensor node shall be factory calibrated at a minimum of 16 air flow rates and 3 temperatures to standards that are traceable to the national Institute of Standards and Technology (NIST). Thermistor sensor calibrations traceable only to temperature standards are not acceptable.

3) Temperature accuracy shall be +/-0.14 degrees F (0.08 degrees C) over the entire operating temperature range of -20 degrees F to 160 degrees F (-28.9 degrees C to 71 degrees C).

4) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing). Product design shall consider direct exposure to or immersion in liquid water and temporary exposure shall not damage the sensing elements.

5) Each sensor or probe assembly shall not require matching to the transmitter in the field.

6) A single manufacturer shall provide both the air flow/temperature measuring probe(s) and transmitter for each measurement location.

f. Duct and Plenum Probes

1) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tubes. All internal wires within the tube shall be Kynar coated. PVC insulated conductors are not acceptable.

2) Sensor probe design shall be capable of providing up to 4 sensor nodes per probe.

3) Air flow accuracy shall be +/-2% of reading over the entire operating air flow range of not less than zero to 5,000 feet per minute (zero to 25.4 meters per second).

(a) Devices whose overall performance at the host controller input terminals is the combined accuracy of the transmitter and sensor probes shall demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

4) Each ducted sensor probe shall have an integral, U.L. listed, plenum rated cable. Cable jackets and conductor insulation shall be FEP, Teflon-FEP or Neoflon-FEP. Cables shall include a terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated. PVC jacketed cables of PVC insulated conductors are not acceptable with ducted sensor probes.

g. Fan Inlet Sensor Probes

1) Each sensor node, consisting of at least two thermistor-sensors and their structural housing, shall independently determine the air flow rate and temperature at each measurement point.

2) Air flow accuracy shall be +/-2% of reading over the entire operating air flow range of not less than zero to 10,000 feet per minute (zero to 50.8 meters per second).

(a) Devices whose overall performance at the host controller input terminals is the combined accuracy of the transmitter and sensor probes shall demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

3) Sensor node assemblies shall be mounted on Type 304 stainless steel housings.

4) Mounting rods shall be field adjustable to fit the fan inlet and constructed of zinc plated steel.

5) Mounting feet shall be constructed of Type 304 stainless steel.

6) Mounting style shall be "face mount" or "throat mount" unless noted otherwise.

(a) Face mounting style shall provide no mechanical fastening in the throat or on the surface of the inlet cone and shall be used on all inlet condition-sensitive plenum-type or plug fans.

7) Fan inlet probe cables shall be UL plenum-rated and may be FEP jacketed. Provide length as required based on transmitter location.

6. Thermal Dispersion Sensor Transmitters

a. The transmitter shall have an integral LCD display capable of simultaneously displaying air flow and temperature. The LCD display shall be capable of displaying individual air flow and temperature readings of each independent sensor node.

b. The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.

c. The transmitter shall have an on-off power switch and operate on 24 VAC. Isolation transformers shall not be required. Power shall be extended from local BAS panel.

1) The transmitter shall use a switching power supply, fused and protected from transients and power surges.

2) The transmitter shall use "watch-dog" circuitry to assure automatic reset after power disruption, transients and brown-outs.

d. All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.

e. The operating temperature range for the transmitter shall be -20 degrees F to 120 degrees F (-28.9 degrees C to 48.9 degrees C). The transmitter shall be installed at a location that is protected from weather and water.

f. The transmitter shall be capable of communicating with other devices using one of the following interface options:

1) Linear analog output signals for air flow and temperature: Field selectable, fuse protected and electrically isolated from all other circuitry, 0-5VDS / 0-10VDC / 4-20mA (4-wire).

2) RS-485: Field selectable BACnet/MS/TP, BACnet-ARCNET, Modbus-RTU or Johnson Controls N2-Bus.

(a) BACnet devices shall provide analog variables for air flow and temperature containing individual sensor air flow rate and temperature data.

3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP.

g. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of air flow and temperature using a MS Windows-based PC.

7. Static Pressure Traverse Probe

a. Acceptable manufacturers: Air Monitor Corp., Cleveland Controls, or Paragon Controls.

1) Substitutions: Refer to Division 01.

b. Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.

c. Shielded Static Air Probe

1) A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and air flow shielding. A suitable probe for indoor and outdoor locations shall be provided.

F. Water Flow Monitoring

1. Water Flow Monitoring

a. Acceptable manufacturers: Omega, Onicon, or Siemens.

1) Substitutions: Refer to Division 01.

b. Water flow meters shall be electromagnetic in-line type with integral Microprocessor-based electronics. The meter shall have an accuracy of 0.25%.

G. Thermal Mass Flow Meters (Natural Gas or Compressed Air)

1. Acceptable manufacturers: Onicon, Sierra Instruments, or Sage Metering

2. Description: Thermal mass flow meter to provide accurate flow measurement of natural gas, propane gas and compressed air for sub-metering. Provide with integral display with remote monitoring through a BACnet MS/TP or Modbus RTU connection to the BAS. Unit shall be FM approved. Provide flanged connections for 2-1/2" and larger piping; NPT for 2" and smaller. Unit shall have field validation and test functions to verify calibration and diagnostics.

3. Material: 316 Stainless Steel

4. Accuracy: +/- 1% of reading, +/- 0.5% of full scale

5. Turndown: 100 to 1

6. Pressure drop: 0.9" W.C. at 2500 SFPM at 70 degrees F and 2 psig.

7. Type: In-line

8. Input Power: 12 to 28VDC

9. Output signal: 4-20 mA analog with RS-232 or RS-485 interface

10. Max operating pressure: 230 psig at 100 degrees F

11. Ambient Temperature range: -40 degrees F to 120 degrees F

12. Display: Bright, high contrast LCD or LED display of flow rate, totalized flow and temperature in a weatherproof aluminum or stainless steel NEMA 4X enclosure.

13. Programming: Factory programmed with non-volatile memory in the event of a power loss. Field programming available with user definable pulse output for totalized flow.

H. Power Monitoring Devices

1. Acceptable manufacturers: Veris Industries.

a. Substitutions: Refer to Division 01.

2. Current Measurement (Amps)

a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

b. Current Transformer - A split core current transformer shall be provided to monitor motor amps.

1) Operating frequency - 50 - 400 Hz.

2) Insulation - 0.6 Kv class 10Kv BIL.

3) UL recognized.

4) Five amp secondary.

5) Select current ration as appropriate for application.

6) Acceptable manufacturers: Veris Industries

c. Current Transducer - A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

1) 6X input over amp rating for AC inrushes of up to 120 amps.

2) Manufactured to UL 1244.

3) Accuracy: +.5%, Ripple +1%.

4) Minimum load resistance 30kOhm.

5) Input 0-20 Amps.

6) Output 4-20 mA.

7) Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).

I. Smoke Detectors

1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 28. for installation under Division 23. All wiring for air duct detectors shall be provided under Division 28, Fire Alarm System. Coordinate interface with BAS and Fire Alarm System.

J. Status and Safety Switches

1. General Requirements

a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BAS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches

a. Acceptable manufacturers: Veris Industries.

1) Substitutions: Refer to Division 01.

b. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

c. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

d. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

3. Air Filter Status Switches

a. Acceptable manufacturers: Automated Logic, Cleveland Controls, Johnson Controls, or Siemens.

1) Substitutions: Refer to Division 01.

b. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

c. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.

d. Provide appropriate scale range and differential adjustment for intended service.

4. Air Flow Switches

a. Acceptable manufacturers: Automated Logic, Cleveland Controls, Johnson Controls, or Siemens.

1) Substitutions: Refer to Division 01.

b. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

c. Acceptable manufacturers: Johnson Controls, Cleveland Controls

5. Air Pressure Safety Switches

a. Acceptable manufacturers: Automated Logic, Cleveland Controls, Johnson Controls, or Siemens.

1) Substitutions: Refer to Division 01.

b. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.

c. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

6. Differential Pressure / Water Flow Switches

a. Acceptable manufacturers: Johnson Controls (model P74).

1) Substitutions: Refer to Division 01.

b. Switch shall contain heavy duty pressure elements and be used to measure and relay the pressure difference between two sources or across the inlet/outlet of equipment.

c. Device shall be an automatic reset device and shall provide a control output at the differential pressure setpoint.

7. Low Temperature Limit Switches

a. Acceptable manufacturers: Johnson Controls (model A70).

1) Substitutions: Refer to Division 01.

b. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

c. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.

d. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

2.3 OUTPUT DEVICES

A. Actuators

1. Acceptable manufacturers: Belimo, Johnson Controls, or Mamac

a. Substitutions: Refer to Division 01.

2. General Requirements

a. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.

3. Electronic Damper Actuators

a. Electronic damper actuators shall be direct shaft mount.

b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.

c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

B. Control Dampers

1. The BAS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BAS Contractor or as specifically indicated on the Drawings.

2. All dampers used for throttling air flow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.

3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.

5. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Johnson Controls D-7250 D-1250 or D-1300, Ruskin CD50, and Vent Products 5650.

6. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Johnson Controls D-1600, Ruskin CD36, and Vent Products 5800.

7. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C. Control Relays

1. Control Pilot Relays

a. Acceptable manufacturers: Johnson Controls or Lectro.

1) Substitutions: Refer to Division 01.

b. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

c. Mounting Bases shall be snap-mount.

d. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

e. Contacts shall be rated for 10 amps at 120VAC.

f. Relays shall have an integral indicator light and check button.

2. Lighting Control Relays

a. Lighting control relays shall be latching with integral status contacts.

b. Contacts shall be rated for 20 amps at 277 VAC.

c. The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.

d. Lighting control relays shall be controlled by:

1) Pulsed Tri-state Output - Preferred method.

2) Pulsed Paired Binary Outputs.

3) A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the "dry-contact" type.

e. The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.

D. Electronic Signal Isolation Transducers

1. Acceptable manufacturers: Advanced Control Technologies.

a. Substitutions: Refer to Division 01.

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

3. The signal isolation transducer shall provide ground plane isolation between systems.

4. Signals shall provide optical isolation between systems.

E. External Manual Override Stations

1. External manual override stations shall provide the following:

a. An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.

b. A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.

c. A Status LED shall illuminate whenever the output is ON.

d. An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.

e. Contacts shall be rated for a minimum of 1 amp at 24 VAC.

2.4 MISCELLANEOUS DEVICES

A. Local Control Panels

1. All control panels shall be factory constructed, incorporating the BAS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch. Provide common keying for all new panels and match keying when existing panels are present.

2. Control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices-such as relays, transducers, and so forth-that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.

3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.

4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

5. All wiring shall be neatly installed in plastic trays or tie-wrapped.

6. A 120 VAC duplex convenience receptacle and required transformers shall be provided in each enclosure.

B. Power Supplies

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

2. Input: 120 VAC +10%, 60Hz.

3. Output: 24 VDC.

4. Line Regulation: +0.05% for 10% line change.

5. Load Regulation: +0.05% for 50% load change.

6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.

7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.

8. A power disconnect switch shall be provided next to each power supply.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Actuation / Control Type

1. Primary Equipment

a. Controls shall be provided by equipment manufacturer as specified herein.

b. All damper and valve actuation shall be electric.

2. Air Handling Equipment

a. All air handlers shall be controlled with a HVAC-DDC Controller

b. All damper and valve actuation shall be electric.

B. HVAC Input Devices - General

1. All Input devices shall be installed per the manufacturer recommendation.

2. Locate components of the BAS in accessible local control panels wherever possible.

a. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, air flow stations, etc.

3. Flow Measuring Devices shall be installed in strict compliance with ASHRAE and ASME guidelines affecting non-standard approach conditions.

4. Outside Air Sensors

a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.

b. Sensors shall be installed with a rain proof, perforated cover.

5. Building Differential Air Pressure Applications (-1" to +1" w.c.)

a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.

b. The interior tip shall be inconspicuous and located as shown on the drawings.

6. Air Flow Measuring Stations

a. Install air flow measuring stations in accordance with manufacturer's instructions at the locations indicated on the plans including clear distances to adjacent fittings, elbows, inlets, or other interference. A written report shall be

submitted to the Engineer if any discrepancies exist or if installation cannot be completed per the manufacturer's recommendations.

b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

7. Duct Temperature Sensors

a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.

b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.

c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.

d. The sensor shall be mounted to suitable supports using factory approved element holders.

8. Space Sensors

a. Mounted per ADA requirements.

9. Averaging and Low Temperature Limit Switches

a. Install as indicated in the control diagram.

b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by at least 1 foot of sensor.

c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to obtain full coverage.

10. Air Differential Pressure Status Switches

a. Install with static pressure tips, tubing, fittings, and air filter.

11. Water Differential Pressure Status Switches

a. Install with shut off valves for isolation.

C. HVAC Output Devices

1. All output devices shall be installed per the manufacturer's recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, air flow stations, pressure wells, etc.

2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the

entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

3. Control Dampers: Shall be opposed blade for modulating control of air flow. Parallel blade dampers shall be installed for two position applications.

4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.

5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the BAS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.2 TRAINING

A. The BAS contractor shall provide the following training services:

1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BAS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.3 COMMISSIONING

A. Fully commission all aspects of the Building Management System work.

B. Acceptance Check Sheet

1. Prepare a check sheet that includes all points for all functions of the BAS as indicated on the point list included in this specification.

2. Submit the check sheet to the Engineer for approval

3. The Engineer will use the check sheet as the basis for acceptance with the BAS Contractor.

C. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

END OF SECTION

SECTION 23 09 23
BUILDING AUTOMATION SYSTEMS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Components and equipment requirements:

1. Management Level:

   a. Application and Data Server

   b. Operator Work Station

2. Supervisory Level:

   a. Automation Controllers

   b. Integration Controllers

3. Field Controller Level:

   a. Custom Application Programmable Controllers for project specific requirements to control or interface with:

      1) Exhaust systems

         (a) General

   b. Application Specific Controllers

      1) DX Unit Controllers (packaged, split, heat pump)

4. Connectivity, communication and other components required for complete operation of the Building Automation System.

B. Automation, control, monitoring, reporting and user interface requirements.

C. Installation requirements.

D. Completion and Start Up requirements.

1.2 RELATED SECTIONS

A. 230913 Instrumentation and Control Devices

1.3 WORK INCLUDED

A. The BAS shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that

mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BAS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN. If requested by the facility, the BAS shall operate on a separate, dedicated network provided and installed by the BAS vendor.

B. Any and all components of the BAS that are connected via field bus or IP network, including the network controllers, field controllers, application specific controllers, server and user interface software, system and controller programming tools and software applications shall be designed, engineered, and tested to work together as a complete building management system, and shall be manufactured by the same BAS manufacturer. Systems that use or require network controllers, field controllers, application specific controllers, server and user interface software, programming tools and software from more than one BAS manufacturer shall not be accepted.

C. All points of user interface shall be on standard computing devices that do not require the purchase of any special software from the BAS manufacturer for use as a building operations terminal. The primary point of interface on these devices will be a standard Web Browser.

D. Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft SQL Server Express or Microsoft SQL Server as dictated elsewhere in this specification.

E. The BAS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BAS.

F. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

G. Manage and coordinate the BAS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as not to impede or delay the work of associated trades.

H. The BAS as provided shall incorporate, at minimum, the following integrated features, functions and services:

1. Operator information, alarm management and equipment/systems control functions.

2. Information management including monitoring, transmission, archiving, retrieval, trending and reporting functions.

3. Diagnostic monitoring and reporting of BAS functions.

4. Energy management.

5. Standard applications for terminal HVAC systems.

6. Enterprise-wide information and control access.

7. Offsite monitoring and management access.

8. Indoor Air Quality monitoring and control.

9. Coordination with Fire Alarm System in operation of smoke dampers and start/stop of equipment upon activation of fire alarm.

10. Coordination with Fire Alarm System in operation of smoke control systems.

1.4 QUALITY ASSURANCE

A. General

1. The BAS Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated BAS.

2. The BAS Contractor shall be a recognized national manufacturer, installer and service provider of BMS.

3. The BAS installer shall be a BAS manufacturer-owned branch office or an independent controls contractor who is factory trained and authorized by the BAS manufacturer to sell, service and support the BAS specified herein.

4. Independent controls contractors who are authorized by the BAS manufacturer must provide a letter written and signed by a company officer of the specific BAS manufacturer. This document must be dated within the 30 days prior to bid submittal and must state that they are currently a “direct authorized representative” in good standing for the BAS manufacturer for the building management system products described and listed in this specification, that they have “direct purchasing access” to all of the BAS manufacturer’s controllers, servers, software and components and technical support, and that they will continue to be an Authorized representative with this access for the duration of the installation and warranty phases of project.

5. The BAS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis. The BAS Contractor shall have, at this facility, a trained, directly employed and

full time technical staff, spare parts inventory, and all necessary test and diagnostic equipment.

6. As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the BAS business for at least the last ten (10) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.

7. The BAS architecture shall consist of the products of

8. a manufacturer regularly engaged in the production of BAS, and shall be the manufacturer's latest standard of design at the time of bid.

B. Quality Management Program

1. Designate a competent and experienced employee to provide BAS Project Management. The designated Project Manager shall be empowered to make technical, scheduling and related decisions on behalf of the BAS Contractor. At minimum, the Project Manager shall:

   a. Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.

   b. Manage the financial aspects of the BAS Contract.

   c. Coordinate as necessary with other trades.

   d. Be responsible for the work and actions of the BAS workforce on site.

1.5 REFERENCES

A. All work shall conform to the following Codes and Standards, as applicable:

1. National Fire Protection Association (NFPA) Standards.

2. National Electric Code (NEC) and applicable local Electric Code.

3. UL listing and labels.

4. UL 268 Smoke Detectors.

5. UL 916 Energy Management.

6. NFPA 70 – National Electrical Code.

7. NFPA 90A – Standard For The Installation Of Air Conditioning And Ventilating Systems.

8. Factory Mutual (FM).

9. American National Standards Institute (ANSI).

10. National Electric Manufacturer's Association (NEMA).
11. American Society of Mechanical Engineers (ASME).
12. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
13. Air Movement and Control Association (AMCA).
14. Institute of Electrical and Electronic Engineers (IEEE).
15. American Standard Code for Information Interchange (ASCII).
16. Electronics Industries Association (EIA).
17. Occupational Safety and Health Administration (OSHA).
18. American Society for Testing and Materials (ASTM).
19. Federal Communications Commission (FCC) including Part 15, RF Devices.
20. Americans Disability Act (ADA).
21. ANSI/EIA 909.1-A-1999 (LonWorks®).
22. ANSI/ASHRAE Standard 195 (BACnet).

B. In the case of conflicts or discrepancies, the more stringent regulation shall apply.

C. All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.6 SUBMITTALS

A. Shop Drawings, Product Data, and Samples

1. The BAS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.
2. Coordinate and obtain approval of proposed point naming convention from owner before developing system submittal package.
3. Submittals shall be in defined packages. Each package shall be complete, shall only reference itself, and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
4. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BAS work.
5. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BAS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.

6. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.

7. The BAS Contractor shall correct any errors or omissions noted in the first review.

8. At a minimum, submit the following:

    a. BAS network architecture diagrams including all nodes and interconnections.

    b. Systems schematics, sequences, and flow diagrams.

    c. Points schedule for each point in the BAS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.

    d. Samples of Graphic Display screen types and associated menus.

    e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.

    f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.

    g. Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address.

    h. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close-off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.

    i. Details of all BAS interfaces and connections to the work of other trades.

    j. Product data sheets or marked catalog pages including part number, photo and description for all products including software

    k. List of reports and trends as noted on control drawings and sample formats for all.

9. Existing Systems Inventory

    a. Where applicable, provide a complete and current BAS site inventory for all existing field and supervisory controllers to be integrated into the new BAS including manufacturer, model number, firmware version, available updates, battery condition, integrations, controlled equipment, and point counts.

    b. Site inventory shall be provided on a separate, new USB compatible flash drive.

B. Record Documentation

1. Operation and Maintenance Manuals.

a. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media or USB Flash Drive, and include the following for the BAS provided:

b. Table of contents.

c. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.

d. Manufacturer’s product data sheets or catalog pages for all products including software.

e. System Operator’s manuals.

f. Archive copy of all site-specific databases and sequences.

g. BAS network diagrams.

h. Interfaces to all third party products and work by other trades.

2. The Operation and Maintenance Manual shall be self-contained, and include all necessary software required to access the product data sheets. Include a logically organized table of contents. Viewer software shall provide the ability to display, zoom, print, and search all documents.

3. On-Line documentation: After completion of all tests and adjustments the contractor shall provide a back-up copy of all installed sequences, information and product data to be installed on a customer designated computer workstation or server.

1.7 WARRANTY

A. Standard Material and Labor Warranty:

1. Provide a one-year labor and material warranty on the BAS.

2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BAS Contractor at the cost of the BAS Contractor.

B. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BAS Contractor’s normal business hours.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Johnson Controls, Metasys.

B. Honeywell, Enterprise Building Integrator (EBI).

C. Siemens Building Systems, APOGEE.

D. Other

2.2 GENERAL REQUIREMENTS

A. The BAS shall use an open architecture, shall fully support a multi-vendor environment and shall support open communication protocol standards. The system shall be designed for use on the Internet or intranets, using industry standard technology compatible with other owner provided network.

B. Coordinate point naming nomenclature with owner's facility identification system (by building name/number, floor, area, system, etc). Submit proposed naming convention before submitting formal system layout and information.

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

D. The system shall use wired connections for communication to and from field devices (controllers, dampers and valves), sensors (both exposed in spaces and concealed in panels), panels, server and HMI devices.

E. System layout shall include provision of sufficient panel capacity for additional 10% of points for following point types: air and water temp sensors, valve and damper actuators, humidity sensors, level sensors, air and water flow sensors. Provide additional communication ports for Network Controllers as noted in sections herein.

F. System layout shall include minimum of one Network Level panel per floor on multistory buildings.

G. System layout shall include sufficient Network Controllers to limit network traffic on each controller's local operating network to less than 75% of maximum network bandwidth or 80% of available system resource count.

H. System architectural design shall not depend upon any single device for alarm reporting and control execution.

I. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

J. The system shall maintain all settings and overrides through a system reboot.

K. The system shall not depend upon any single device for alarm reporting and control execution.

L. The installed system shall comply with the following NFPA Codes and Standards as applicable

1. NFPA 70 National Electrical Code.

2. NFPA 72 National Fire Alarm Code.

3. NFPA 101 Life Safety Code.

4. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilation Systems.

5. International Code Council (ICC) Codes

2.3 CONTROL PANELS

A. Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide laminated as-built wiring diagrams, flow diagrams, etc. related to the system being controlled inside the associated cabinet. Each control panel shall be clearly and permanently labeled with the controller designation and indication of the mechanical equipment served.

B. Unitized cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels. Keying shall be unique to the project, and only the keys supplied for the project shall be capable of unlocking the panels for the project.

C. Fabricate panels of furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.

D. Provide minimum NEMA 12 rating for indoor application and NEMA 4X rating for outdoor application or the appropriate NEMA rating for application. Electrical piping and wiring shall be penetrated through the bottom of the panel with 4 inches nipples and 4 inches wiring trough.

E. Coordinate location and installation of the control panels with other trades.

F. All control panels shall be provided with DIN Rail mounted screw terminal blocks. Field wiring shall be connected to the screw terminal blocks. It is not acceptable to terminate any field wiring directly to the DDC controller or any panel devices such as relay and transducers. The screw terminal blocks located/attached to the DDC controller alone does not comply with this requirement.

G. All control devices such as relays, transformers, transducers, power supplies, associated I/O devices, etc. shall be installed inside the panel, not at the starter or electrical junction box.

H. All panel wiring shall in be installed in Panduit and wiring duct. This shall include but not be limited to wiring from the DDC controller to the terminal block, between DDC controller and relay (and other panel mounted control devices), power wiring for the controller, communication, etc.

I. Panels should be ventilated or mechanically cooled to prevent excessive heat build-up.

2.4 SAFETIES

A. All power distribution within the IAS shall make requisite use of electrical safety devices, such as fuses and circuit breakers

B. All materials supplied as a part of the IAS shall be non-hazardous in nature. Where suitability of specific components or devices are called into question, this Contractor shall supply the relevant Materials Safety Data Sheet to the Owner and/or Engineer

2.5 MANAGEMENT LEVEL

A. Capabilities

1. The management level network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.

2. All BAS devices at the Management levels shall be capable of operating at a minimum communication speed of 100 Mbps, with full peer-to-peer network communication.

B. Equipment and Access Requirements

1. Application and Data Servers

a. The Application and Data Server (ADS) shall manage the collection and presentation of large amounts of trend data, event messages, operator transactions, and system configuration data on the BMS.

b. The ADS shall not restrict access to the individual Network Controllers in the event of individual component failure or a loss of communication.

c. The ADS shall act as a server for the following functionality as described in these specifications:

1) Mobile user interface providing user friendly access to system information via site navigation by place or device.

2) Site Management Portal functions and applications.

3) System Configuration Tool controller configuration and programming.

d. The ADS shall be capable of supporting up to ten simultaneous users via Web client access.

e. User Authentication –support local users, Active Directory users, Microsoft Office 365 users and Remote Authentication Dial-in User Service (RADIUS).

f. The ADS shall support the addition of optional software packages for advanced reporting and essential energy information.

g. The ADS shall provide historical and configuration data reporting capabilities in a user interface that is separate from the site management user interface, allowing authorized users to run reports for immediate review in a web browser including:

1) Configuration Setup Report.

2) System Operation Report.

3) Trend Report including user defined parameters

4) Trend Detail Report – including summary data

h. The ADS shall support all following Web Client operating systems:

1) Microsoft Windows 7, 8.1, 10 (Professional, Enterprise, Ultimate, Anniversary.)

2) Apple OS X 10.8, 10.9, 10.10, 10.11.

i. The ADS shall support all following Web Browsers:

1) Microsoft Internet Explorer 11, Edge.

2) Apple Safari Ver. 10.0 or higher.

3) Google Chrome Ver. 49 or higher

2. Operator Workstation

a. Where indicated on plans the BAS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. Real-time control functions, including scheduling, history collection and alarming, shall not be dependent on the OWS but shall be resident in the BAS Network Controllers and Data Server.

b. Workstation Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BAS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.

1) Microsoft Internet Explorer 11.0 or Edge for user interface functions.

2) Microsoft Office Professional, including Word and Excel, for creation, modification and maintenance of reports, sequences other necessary building management functions.

3) Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports.

4) Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.

5) Provide one operational device as located on plans.

c. Provide a compatible printer:

1) HP Color Deskjet or equal

2) Print speed – 600 DPI Black, 300 DPI Color

3) Buffer – 64 K Input Print Buffer

C. User Interface Application Components

1. Operator Interface

a. An integrated browser based client application shall be used as the user operator interface program. All inputs, outputs, setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

b. The user interface software shall provide help menus and instructions for each operation and/or application. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

c. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

1) User access for selective information retrieval and control command execution

2) Monitoring and reporting

3) Alarm, non-normal, and return to normal condition annunciation

4) Selective operator override and other control actions

5) Information archiving, manipulation, formatting, display and reporting

6) BAS internal performance supervision and diagnostics

7) On-line access to user HELP menus

8) On-line access to current BAS as-built records and documentation Means for the controlled re-programming, re-configuration of BAS operation and for the manipulation of BAS database information in compliance with the prevailing codes, approvals and regulations for individual BAS applications.

d. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

2. Navigation Trees

a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.

b. Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

c. The navigation trees shall be "dockable" to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

3. Alarms

a. Alarms shall be routed directly to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers.

b. The alarm management portion of the user interface shall, at the minimum, provide the following functions:

1) Log date and time of alarm occurrence.

2) Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.

3) Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.

4) Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall

include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.

5) Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

6) Any attribute of any object in the system may be designated to report an alarm.

c. The BAS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.

d. The BAS shall annunciate application alarms as specified herein and as shown on Drawings.

4. Reports and Summaries

a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

1) All points in the BAS

2) All points in each BAS application

3) All points in a specific controller

4) All points in a user-defined group

5) All points currently in alarm

6) All points locked out

7) All points in override

8) All BAS schedules

9) All user defined and adjustable variables, schedules, and interlocks.

b. Summaries and Reports shall be accessible via standard user interface functions and not dependent upon custom programming or user defined HTML pages.

c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.

d. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.

5. Schedules

a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:

1) Weekly schedules

2) Exception Schedules

3) Monthly calendars.

4) Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

5) It shall be possible to define one or more exception schedules for each schedule including references to calendars

6) Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.

7) Changes to schedules made from the User Interface shall directly modify the affected controller(s) schedule database.

8) Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard. Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

6. Password

a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.

b. Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.

c. The system shall allow each user to change his or her password at will.

d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

e. A minimum of five levels of access shall be supported individually or in any combination as follows:

1) Level 1 = View Data

2) Level 2 = Command

3) Level 3 = Operator Overrides

4) Level 4 = Database Modification

5) Level 5 = Database Configuration

6) Level 6 = All privileges, including Password Add/Modify

f. A minimum of 100 unique passwords shall be supported.

g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.

h. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

7. Screen Manager

a. The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

8. Dynamic Color Graphics

a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or workstation applications that rely only upon HTML pages shall not be acceptable.

b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.

c. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered. A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:

1) All graphics shall be fully scalable

2) The graphics shall support a maintained aspect ratio.

3) Multiple fonts shall be supported.

4) Unique background shall be assignable on a per graphic basis.

5) The color of all animations and values on displays shall indicate if the status of the object attribute.

d. It shall be possible to change setpoints and states in system controlled equipment by using drop-down windows accessible via the pointing device.

e. A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.

1) The graphic editing tool shall provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.

2) The graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.

f. Aliasing - Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. It shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

9. Historical trending and data collection

a. Each controller shall store trend and point history data for all analog and digital inputs and outputs, as follows:

1) Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:

(a) Defined time interval

(b) Upon a change of value

(c) Upon reaching a user input threshold value

2) Each controller shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

3) Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.

4) The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.

10. Trend data viewing and analysis

a. Provide a trend viewing utility that shall have access to all database points.

b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.

c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends

d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as range, color, and plot style.

e. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.

f. A zoom capability shall be provided to adjust the display magnitude and units as selected by the operator at any time without reconfiguring the processing or collection of data.

g. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

D. Configuration Capability

1. System Configuration

a. BAS shall include a software package enabling a computer platform to be used for stand-alone configuration of a Network Controller.

b. Shall provide an archive database for the configuration and application data.

c. Shall include the following features:

1) Basic system navigation tree for connected networks.

2) Integration of LonWorks and BACnet enabled devices.

3) Customized user navigation trees.

4) Point naming operating parameter setting.

5) Graphic diagram configuration.

6) Alarm and event message routing.

7) Graphical logic connector tool for custom programming.

8) Downloading, uploading, and archiving databases.

d. Shall provide a site discovery feature to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:

1) BACnet Devices.

2) LonWorks devices

3) Network Level devices

4) System Application Level devices.

e. Shall be capable of programming the Network Control Level and Field Application Level Controllers.

f. Shall contain a library of standard applications to be used for configuration.

g. A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.

h. Shall allow the PC to access configuration tool through the web browser using the user interface.

i. Shall use the Bluetooth Wireless Technology.

2. Controller Configuration

a. Shall be used to configure, simulate and commission custom application and application specific controllers.

b. Shall operate in distinct modes to facilitate efficiency at various steps in the steps leading to project completion as well as future upgrades and maintenance:

1) Allows users to select various mechanical and control logic options through selection trees for typical air handling, terminal unit, and central plant applications.

2) Shall include a simulation mode to allow the user to review all application logic as if the device were operating in a connected systems environment.

3) Shall include a commissioning mode to allow users to validate all sensor and control point interfaces and to adjust key setpoints and setup parameters once the device is mounted and connected in an operational environment.

4) Shall provide multiple options for downloading files to the controllers including direct wired, wireless and Ethernet pass thru as dictated by controller type and location.

2.6 SUPERVISORY LEVEL

A. Capabilities

1. The Supervisory level network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.

2. All BAS devices at the Supervisory level shall be capable of operating at a minimum communication speed of 100 Mbps, with full peer-to-peer network communication.

3. Controllers shall provide supervisory control over the control network and shall support the following communication protocols:

   a. BACnet Standard Master-Slave/Token-Passing (MS/TP) Bus Protocol ASHRAE SSPC-135:

   b. LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).

   c. Existing facility BAS control bus.

   d. Modbus® TCP and RTU.

4. Controllers shall be fully user-programmable, supervisory controller with capability to monitor the network of distributed field application and field device controllers and communicate on a peer-to-peer basis with other Supervisor Controllers.

5. Controllers shall be BTL certified and carry the BTL Label.

6. Controllers shall be tested and certified as a BACnet Building Controller (B-BC).

7. Default network communication protocol for this project shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

8. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only, shall not be acceptable.

9. Control network shall support digital controllers as indicated in plans and specifications.

B. Equipment

1. Supervisory Automation Controllers

a. User Interface: all computers connected physically or virtually to the automation network shall have access to the web based user interface.

1) The web based user interface software shall be embedded in the controller. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

2) The controller shall support a minimum of two (2) concurrent users.

3) The web-based user shall have the capability to access all system data through a single controller.

4) Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one controller.

5) Systems that require the user to address more than one controller to access all system information are not acceptable.

6) The controller shall have the capability of generating web based user interface graphics. The graphics capability shall be embedded in the controller.

7) Systems that only support user interface graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

8) The web based user interface shall support the following functions using a standard version of Microsoft Internet Explorer:

(a) Configuration

(b) Commissioning

(c) Data Archiving

(d) Monitoring

(e) Commanding

(f) System Diagnostics

9) Systems that require workstation software or modified web browsers for system queries are not acceptable.

10) Controller shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

b. Controller shall be a multi-tasking, multi-user, and real-time digital microprocessor-based control processor with a minimum word size of 32 bits. Standard operating systems shall be employed. Controller size and capability shall be sufficient to fully meet the requirements of this Specification, including provisions for future additional points as noted previously.

c. Each controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices, including provisions for future additional points noted previously.

d. Controller shall support local users, Active Directory users, Microsoft Office 365 users and Remote Authentication Dial-in User Service (RADIUS).

e. Password Security – Access to the embedded user interface shall require a password of 8 to 50 characters including a minimum of one lower case letter, one upper case letter, one number, and one special character. An alarm shall be generated after three unsuccessful attempts within 15 minutes and the user shall be denied access until permission is renewed by a system administrator.

f. Each controller shall include an integrated, hardware-Based, real-time clock.

g. Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components and shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

h. In the event of the loss of normal power, controller shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

i. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

j. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

k. Controller shall be listed by UL.

l. Controller shall include troubleshooting LED indicators to identify the following conditions:

1) Power – On/Off.

2) Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic.

3) Ethernet Connection Speed – 10 Mbps/100 Mbps.

4) FC Bus – Normal Communications/No Field Communications.

5) Peer Communication – Data Traffic between NAE Devices.

6) Run – Running/in Startup/Shutting Down/Software Not Running.

7) Bat Fault – Battery Defective, Data Protection Battery Not Installed.

8) Fault – General Fault.

9) Modem RX – Modem Receiving Data (as required).

10) Modem TX – Modem Transmitting Data (as required).

m. Communications Ports – Controller shall provide the following ports for operation of operator I/O devices, such as industry-standard computers, modems, and portable operator's terminals:

1) USB port.

2) RS-232 serial data communication port.

3) RS-485 port.

4) Ethernet port.

5) Provide one additional port of each type furnished on controller for future use.

2. Supervisory Integration Controller

a. Network Integration for Third-Party Devices and Equipment –Network Integration Controllers shall be capable to integrate power and energy meters, lighting, large air handling unit controllers, central heating/cooling system controllers, security, access control, and other proprietary systems that communicate over Modbus, M-Bus (EN1434-3) and KNX Bus.

b. Network Integration Controllers shall support standard building management communication technologies, including:

1) BACnet protocol – Controller supports the BACnet services and objects typically used by a workstation and a field controller device, including:

(a) BACnet alarm.

(b) Scheduling.

(c) Trend.

(d) Event services

2) MS/TP FC Bus – The BACnet MS/TP Field Controller (FC) Bus is a standard peer-to-peer, multiple-master protocol in which each master device takes turns originating messages to pass to any device on the bus.

3) LonWorks protocol – Specified models can supervise LonWorks devices if

(a) The network interface follows current LonMark guidelines.

(b) Uses the Free Topology Transceiver (FTT10).

4) Modbus – NIEs support both Modbus RTU (RS-485, RS-232) and Modbus TCP/IP connectivity.

(a) M-Bus (EN 1434-3) – M-Bus (Meter Bus) is a European standard (EN 1434-3) that applies primarily to heat meters.

(b) KNX protocol – KNX Bus applies for the control of lighting, blinds and shutters, heating, and attendance systems.

(1) KNX (KONNEX) was created from the EIB (European Installation Bus), BatiBUS, and EHS (European Home System) protocols.

(2) A KNX IP Gateway is required to connect to a KNX network.

c. User Interface: all computers connected physically or virtually to the automation network shall have access to the web based user interface.

1) The web based user interface software shall be embedded in the controller. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

2) The controller shall support a minimum of two (2) concurrent users.

3) The controller shall have the capability of generating web based user interface graphics. The graphics capability shall be embedded in the controller.

4) Systems that only support user interface graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

5) The web based user interface shall support the following functions using a standard version of Microsoft Internet Explorer:

(a) Configuration

(b) Commissioning

(c) Data Archiving

(d) Monitoring

(e) Commanding

(f) System Diagnostics

6) Systems that require workstation software or modified web browsers for system queries are not acceptable.

7) Controller shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

d. User Authentication –Controller shall support local users, Active Directory users, Microsoft Office 365 users and Remote Authentication Dial-in User Service (RADIUS).

e. Password Security – Access to the embedded user interface shall require a password of 8 to 50 characters including a minimum of one lower case letter, one upper case letter, one number, and one special character. An alarm shall be generated after three unsuccessful attempts within 15 minutes and the user shall be denied a system administrator renews access until permission.

f. Controller shall employ finite state programming engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

g. Controller shall be a multi-tasking, multi-user, and real-time digital microprocessor-based control processor with a minimum word size of 32 bits. Standard operating systems shall be employed. Controller size and capability shall be sufficient to fully meet the requirements of this Specification, including provisions for future additional points as noted previously.

h. Each controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices, including provisions for future additional points noted previously.

i. Controller shall include an integrated, hardware-based, real-time clock.

j. Except as otherwise noted each controller shall employ nonvolatile Flash memory to store all programs and data. The controller shall employ a data protection battery to save data and power the real time clock when primary power is interrupted.

k. Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components and shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

l. In the event of the loss of normal power, controller shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

m. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

n. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

o. Controller shall be listed by UL. File E107041, CCN PAZX, UL 916, Energy Management Equipment. FCC Compliant to CFR47, Part 15, Subpart B, Class A.

p. Controller shall include troubleshooting LED indicators to identify the following conditions:

1) Power – On/Off.

2) Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic.

3) Ethernet Connection Speed – 10 Mbps/100 Mbps.

4) FC Bus – Normal Communications/No Field Communications.

5) Peer Communication – Data Traffic between NIE Devices.

6) Run – NIE Running/NIE in Startup/NIE Shutting Down/Software Not Running.

7) Bat Fault – Battery Defective, Data Protection Battery Not Installed.

8) Fault – General Fault.

9) Modem RX – NIE Modem Receiving Data (as required).

10) Modem TX – NIE Modem Transmitting Data (as required).

q. Controller shall provide the following ports for operation of operator I/O devices, such as industry-standard computers, modems, and portable operator's terminals.

1) USB port.

2) RS-232 serial data communication port.

3) RS-485 port.

4) Ethernet port.

5) Provide for one additional port of each type furnished on controller for future use.

2.7 FIELD CONTROL LEVEL – CUSTOM APPLICATION CONTROLLERS

A. Capabilities

1. Fully user-programmable

2. Calendars.

3. Alarms.

4. Trends

5. Able to continue time-based monitoring when offline for extended periods of time from a network.

6. Shall include troubleshooting LED indicators to identify the following conditions (*dependent on connection option)

a. Power On.

b. Power Off.

c. Download or Startup in progress, not ready for normal operation.

d. No Faults.

e. Device Fault.

f. Field Controller Bus – Normal Data Transmission*.

g. Field Controller Bus – No Data Transmission*.

h. Field Controller Bus – No Communication*.

i. Ethernet*.

7. Shall accommodate the direct wiring of analog and binary I/O field points with the following minimum Analog to Digital (A/D) and Digital to Analog (D/A) conversion resolution.

a. Provide a minimum 15 bit A/D resolution for analog inputs.

b. Provide a minimum 15 bit D/A resolution for analog outputs.

8. Shall support the following types of inputs and outputs supplied in the amounts required for the specified applications:

    a. Universal Inputs – shall be configured to monitor any of the following:

        1) Analog Input, Voltage Mode.

        2) Analog Input, Current Mode.

        3) Analog Input, Resistive Mode.

        4) Binary Input, Dry Contact Maintained Mode.

        5) Binary Input, Pulse Counter Mode.

    b. Binary Inputs – shall be configured to monitor either of the following:

        1) Dry Contact Maintained Mode.

        2) Pulse Counter Mode.

    c. Analog Outputs – shall be configured to output either of the following:

        1) Analog Output, Voltage Mode.

        2) Analog Output, Current Mode.

    d. Binary Outputs – shall output the following:

        1) Line-voltage relay outputs.

        2) 24 VAC Triac.

    e. Configurable Outputs – shall be capable of the following:

        1) Analog Output, Voltage Mode

        2) Binary Output Mode.

9. Shall support a Local Controller Display either as an integral part of the controller or as a remote device communicating over the field level bus.

    a. BACnet Standard SSPC-135 MS/TP protocol.

    b. View monitored points without logging into the system.

    c. View and change setpoints, modes of operation, and parameters.

    d. Provide password protection with user adjustable password timeout

    e. Menu driven with separate paths for:

1) Input/Output.

2) Parameter/Setpoint.

3) Overrides.

f. Select the points to be shown and in what order.

g. Back lit LCD with adjustable contrast and brightens and automatic backlight brightening during user interaction.

h. Minimum of 4 lines and a minimum of 20 characters per line on the display

i. Keypad

j. Panel mountable.

2.8 CONTROLLER LEVEL – APPLICATION SPECIFIC CONTROLLERS

A. Capabilities

1. Controller shall be a digital controller that communicates via BACnet MS/TP protocol ASHRAE SSPC-135.

2. Able to operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the field controllers.

3. Control networks shall provide either "Peer-to-Peer", Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.

B. Equipment

1. DX Unit controllers

a. Shall provide both networked and standalone control of split or packaged units:

1) Cooling only units.

2) Cooling units with gas or electric heat.

3) Heat pumps.

4) Units with or without economizers.

b. Shall communicate over the FC Bus using BACnet Standard protocol SSPC-135.

c. BTL certified and carry the BTL Label.

d. Tested and certified as a BACnet Application Specific Controller (B-ASC).

e. Shall include a 4.2 inch LED backlit touch screen with the following configurable icons.

f. Home screen configurable icons include:

1) On/Off icon.

2) Fan override icon.

3) Zone temperature icon.

4) Hold temperature icon.

5) Zone humidity (on applicable models) icon.

6) Occupancy status (on applicable models) icon.

7) Temperature setpoint icon.

8) Alarm icon.

9) Unit status icon.

10) Date/Time icon.

11) Fan override icon.

g. Home screen non-configurable icon includes:

1) Menu icon.

h. Shall provide the flexibility to support any one of the following inputs:

1) Integral indoor air temperature sensor.

2) Analog input for remote air temperature sensing

(a) Remote indoor air temperature sensor.

(b) Analog input for outdoor air temperature sensor.

(c) Analog input for remote temperature monitoring.

3) Two configurable binary inputs with the following configurations:

(a) Disabled.

(b) Occupancy.

(c) Override.

(d) Remote PIR.

(e) Dirty filter.

(f) Service.

(g) Fan Lock.

(h) Open door.

(i) Open window.

i. Shall provide the flexibility to support any one of the following outputs:

1) Up to two heating stages.

2) Up to two cooling stages.

j. Shall provide 4 digit passcode security.

k. Shall provide the flexibility to adjust the following control parameters:

1) Adjustable compressor minimum on time from 0 to 360 seconds.

2) Adjustable compressor minimum off time from 0 to 360 seconds.

3) Adjustable maximum setpoint offset from 0 to 20?F.

4) Adjustable heating minimum on time from 0 to 360 seconds.

5) Adjustable heating minimum off time from 0 to 360 seconds.

6) Adjustable cooling lockout temperature from 0 to 100?F.

7) Adjustable heating lockout temperature from 0 to 100?F.

8) Adjustable supplemental minimum on time from 0 to 360 seconds.

9) Adjustable supplemental minimum off time from 0 to 360 seconds.

10) Adjustable economizer minimum position from 0 to 100%.

11) Adjustable economizer dry bulb setpoint from 0 to 100?F.

12) Adjustable compressor low lockout temperature from -20 to 100?F.

13) Adjustable compressor high lockout temperature from -20 to 100?F.

l. Shall employ nonvolatile electrically EEPROM for all adjustable parameters.

m. The network thermostat shall have a temperature accuracy of ±0.9°F/±0.5°C at 70.0°F/21.0°C typical calibrated.

n. Where required by application and indicated on plans or room schedules provide the controller with an integral Passive Infra-Red (PIR) occupancy sensor model.

o. Shall provide user equipment visibility from a mobile device through the MAP.

PART 3 EXECUTION

3.1 SPECIFIC REQUIREMENTS

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.

2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

B. Custom Reports:

1. Provide custom reports as required for this project.

C. Actuation / Control Type

1. Primary Equipment (chillers, boilers, packaged pumping systems, fan systems with internal controls, etc):

a. Systems shall interface with and/or be controlled with a custom application controller.

b. If controls are provided by equipment manufacturer, BAS shall interface with mfr controls as noted on specific control drawings

c. All damper and valve actuation shall be electric.

2. Air Handling Equipment

a. All air handlers shall be controlled with a custom application controller.

b. All damper and valve actuation shall be electric.

3. Terminal Equipment:

a. Terminal Units shall have electric damper and valve actuation.

b. All Terminal Units shall be controlled with an application specific controller.

3.2 INSTALLATION PRACTICES

A. BAS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the BAS, as herein specified, shall be provided by the BAS Contractor unless specifically shown on the Electrical Drawings under Division 24 Electrical. All wiring shall comply with the requirements of applicable portions of Division 24 and all local and national electric codes, unless specified otherwise in this section.

    a. All BAS wiring materials and installation methods shall comply with BAS manufacturer recommendations.

    b. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BAS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BAS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.

2. Class 2 Wiring

    a. All Class 2 (24 VAC or less) wiring shall be installed in conduit unless otherwise specified.

    b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5’ from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

    c. Class 2 signal wiring and 24 VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.

3. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

4. BAS Line Voltage Power Source

    a. 120-volt AC circuits used for the BAS shall be taken from panel boards and circuit breakers provided by Division 24.

    b. Circuits used for the BMS shall be dedicated to the BAS and shall not be used for any other purposes.

    c. DDC terminal unit controllers may use AC power from motor power circuits.

5. BAS Raceway

    a. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2”.

b. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.

c. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

d. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

6. Penetrations

a. Provide fire stopping for all penetrations used by dedicated BAS conduits and raceways.

b. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

c. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.

d. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

B. BAS Identification Standards

1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.

2. Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

C. BAS Panel Installation

1. The BAS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer’s recommendations.

2. The BAS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

3.3 COMPLETION AND START UP REQUIREMENTS

A. Installation Check Sheet

1. Prepare a check sheet that includes all points for all functions of the BAS as indicated on the point list included in this specification.

2. Validate each physical point is installed correctly, with access for maintenance/replacement.

3. Provide summary of point installation observations, noting insufficient maintenance access, etc.

B. Report Check Sheet

1. Generate a copy of all required reports. Reports shall show setpoint and current real time value for each virtual and physical report.

2. Provide summary of errors/inaccuracies noted in report (out of range differences between point setpoint and value, incorrect alarm values, etc).

C. Submit Installation and Report Check Sheets to Owner and Engineer prior to start of Commissioning or Substantial Completion. For errors/inaccuracies noted in reports, make corrections before proceeding to Commissioning or final start up. Submit revised report after corrections have been made.

D. Provide technical assistance to commissioning agent.

1. Operate BAS to assist in equipment operation for testing, including but not limited to manual positioning of valves, dampers, equipment start/stop, etc.

2. Adjust setpoints, time durations, alarm levels, etc as required to obtain optimum performance of the operating system.

E. Make corrections to installation as required by field testing and commissioning.

F. Provide all reports as specified on a new, USB compatible flash drive.

3.4 TRAINING

A. The BAS contractor shall provide the following training services:

1. One 40 hour week of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BAS software layout and naming conventions, BAS user interface operation, equipment and HVAC system setpoint adjustment, alarm management, report generation and a walk through of the facility to identify panel and device locations.

END OF SECTION

SECTION 23 09 53
DX COOLING AND GAS HEATING AIR ROTATION UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. DX Cooling and Gas Heating Air Rotation System.

1.2 REFERENCES

A. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.
2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
3. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

B. ASTM B75- Standard for copper tubing pressure application.

C. Underwriters Laboratory:

1. The unit shall be manufactured and installed in accordance with the requirements of the Underwriters Laboratory standard; “Ductless Large Open Building Heating and Cooling Equipment - Category LZPG” and bear the official UL Label.

1.3 SUBMITTALS

A. Submittal Procedures: Submittals of all equipment drawings, schedules and specifications must accompany quote.

B. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.

C. Product Data: Submit manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

D. Manufacturer's Installation Instructions: Submit/Indicate rigging and assembly.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of thermostats or other products not mounted on unit.

C. Operation and Maintenance Data: Submit two (2) bound copies of manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum fifteen years documented experience.

1.6 WARRANTY

A. Execution Requirements: Product warranties and product bonds.

B. Furnish 15-year manufacturer warranty on heat exchangers.

C. Furnish five (5) year warranty of burner combustion head.

D. Furnish one (1) year manufacturer parts only warranty for all equipment.

PART 2 PRODUCTS

2.1 AIR ROTATION UNITS

A. Manufacturers:

1. Johnson Air Rotation

2. Substitutions: Per Section 1.5.A: Company specializing in manufacturing products specified in this section with minimum fifteen years documented experience.

B. Self-contained, pre-wired unit consisting of cabinet, supply fan, DX cooling coils, heat exchanger and accessories:

1. The unit shall be designed for outdoor mounting. The unit will have the capabilities of heating, cooling, filtering, and circulating as detailed in the submittal drawing.

2. The unit shall be factory assembled and tested prior to shipping and disassemble for shipping and reassembled on site by the awarded contractor as required.

3. System and accessories to be UL listed and approved as a complete unit. Unit shall be manufactured to FM standards as required. The entire unit assembly must be UL Listed, not just components.

4. Heating fuel: Natural Gas fired.

5. Unit Configuration: Vertical with horizontal discharge. Units shall have control panel serviceable from ground level.

6. Lifting Provisions: Lifting provisions shall be included on all units as an integral part of the equipment.

7. Supply Voltage: 460 V, 3ph., 60 Hz

8. Control Voltage: 120 or 24 volt, 1ph, 60 Hz

9. The unit shall have a single point electrical connection.

C. Frame Construction: Shall be angle iron framing with 3/16" horizontal flange and 1/8" vertical framing and factory painted, suitably reinforced and braced to permit the loading, shipping, unloading and rigging to the unit location and general handling of completed sections without damage to external or internal components or misalignment of factory assembled components due to normal handling techniques.

D. Cabinet Construction: Unit casing shall be double-wall with 18-gauge A-60 bonderized steel suitable for factory painting for outer liner and 22 ga G90 Galvanized for interior liner. The panels shall be factory assembled using flat bar screwed construction and have a reinforced steel angle flange assembly. Unit shall be factory painted using factory standard enamel finish at color of architect's choosing.

E. Access Panels: Hinged access doors in the unit housing shall be provided to permit ready access to all internal components. The access doors shall be a minimum of 18-gauge-galvanized steel. The doors shall be designed to swing out. The doors shall be provided with a continuous 16-gauge stainless steel piano hinge. The unit's wall panels shall an integral part of the doorframe. The unit's fan compartment access for inspection and adjustment shall be UL approved. A warning placard shall be affixed at the access door indicating that the unit is to be shut off before opening the door and entering the fan compartment.

F. Filter Frame and Air Filters: Filter frame shall be fabricated of 16-gauge-galvanized steel. Filters shall be upstream service, mounted in the V-bank position. Filters shall be 90% efficient, 4" pleated (Camfil Farr 855147, or equivalent). APD of filter @ 500 fpm shall not exceed 0.45 " w.g. initial pressure drop. Filters shall be guaranteed against media pack failure to 5.0"

G. Double-Wall Insulation: All sections of the Air Rotation unit shall be double-wall insulated. 2" 1.5# density fiberglass liner with minimum 22 gauge galvanized interior liner. The fan section shall consist of double wall, perforated interior liner.

H. Supply Fans:

1. The supply fans, a minimum of two per unit, shall be airfoil premium propeller type with low-noise blades and a smooth inlet venturi. The pitch of the fan blades shall be field adjustable for ease of air flow adjustment and removal / replacement in case of fan failure. The propeller blades shall be supported by two bearings, which shall be of a self-aligning, ball bearing type and shall be designed for at least 100,000 hours average life.

2. Fans shall have the capacity, and class, as scheduled.

3. Blower Shafts - Blower shafts shall be solid ground and polished. The shafts shall not pass through their first critical speed when the unit comes up to the rated RPM. Shaft shall be coated with a rust inhibitor.

4. V-Belt Drives - All V-belt drives shall be standard capacity dual belt type, furnished in matched sets with reinforced rubber belts. The sheaves shall be of a cast iron type.

5. The service factor used for V-belt drive selection shall be not less than 1.25.

6. Lubrication - Mount all grease fittings directly on the bearings.

7. Motors shall be TEFC, 1800 RPM, 460 volt, 3 phase, 60 Hz. Motor horsepower shall be as indicated on the schedule. Motors will be manufacturer's premium efficiency design.

8. Supply fans with coils in the 'Blow-Through' configuration are not accepted.

9. Units shall be supplied with factory installed motor starters.

I. Cooling Coils:

1. Cooling coils shall be placed in the A-frame position.

2. Cooling coils shall use 0.020" copper tubes and 0.0075" aluminum fins. Coil casings shall be galvanized steel.

3. Drain pans shall be pitched for complete drainage and be constructed of all welded 304 stainless steel. Galvanized drain pans are not acceptable. The underside of the drain pan shall be completely insulated. Intermediate drain pans (as required) shall be stainless steel and have a stainless steel downspout to the lower drain pan.

4. Face velocity of cooling coils shall not exceed 500 fpm.

5. Supply fans with coils in the 'Blow-Through' configuration are not accepted.

6. Access door(s) shall be provided into fan section for motor and drive access. Internal walk-on grating shall be provided in bottom of fan section, full-width and full-length of unit.

J. Heat Exchanger:

1. Multi-pass, welded construction, drum and tube style heat exchanger.

2. Primary surfaces are to be type 400 series stainless steel 11-gauge minimum. All other surfaces are to be type 400 series stainless steel 14-gauge minimum.

3. Heaters that incorporate induced draft fans are not permitted.

K. Gas Burner: Forced draft flame retention type. Burner shall be listed by and bear the UL label.

1. The burner shall be modulating with 10:1 turndown ratio (minimum 50% capacity).

2. The burner shall burn the specified quantity of fuel without objectionable vibration, noise or pulsation with not more than 20% excess air and less than 50 PPM CO in the products of combustion. Manufacturer to submit NO2 generation rates for manufacturer's burner throughout operational range.

3. The burner shall incorporate a stainless steel flame retention type combustion head for long life and efficient operation. Multiport type gas firing heads are preferred and deviation from this specification must be noted.

4. Primary-Secondary air control shall be a design function of the combustion head. Combustion heads requiring an internal adjustment will not be accepted.

5. The burners are to be equipped with a cast blower housing with integral fan scroll. Other types will be accepted based on owner approval and must be submitted as such.

6. A permanent observation port shall be provided in the burner to allow observation of both the pilot and main flame.

L. Gas Train:

1. The gas train piping shall include a 1/4" NPT pressure tapping with 1/4" pipe plug upstream and downstream of valve and regulator in the gas train.

2. Furnish and install one manually operated ball valve upstream of all valves.

3. Provide one main gas pressure regulator with vent to outside atmosphere, in accordance with local codes.

4. A manually operated gas valve shall be located downstream of both automatic gas valves to permit leakage testing of the valves.

5. Gas pressure supervision shall be provided by approved pressure switches interlocked to accomplish a non-recycling safety shutdown in the event of either no or low gas pressure.

M. Gas Burner Safety Controls:

1. An additional temperature high limit safety shall be provided to shut down the burner. Once cooled down burner shall be allowed to operate again.

2. Pre-purge operation of the burner fan shall be provided.

3. A manual restart of the burner shall be necessary in the event of shutdown due to flame failure.

4. All three-phase motors shall be controlled and protected by an automatic starter with thermal overload protection. Starter shall be interlocked to prevent burner operation when overload relays are tripped out.

5. Supply a burner mounted diaphragm airflow switch to prevent the energization of the main fuel valves in the event of insufficient combustion air.

6. A factory pre-wired control cabinet should be supplied with burner. Cabinet is mounted on or near burner. Cabinet to house the flame safeguard control, programming purge timer, burner motor starter, fuses, control switches and relays as specified hereinafter.

7. Provide in the control cabinet individual lights with nameplates to indicate "power on" and "main fuel valve on".

8. The burner shall be equipped with suitable fuel and air controls to assure smooth main flame ignition.

9. Electronic safety combustion controls shall be supplied complete with ultra-violet flame scanner to monitor the pilot and main flame. A programming relay similar to Honeywell RM7897, RM7845 or RM7840 shall be furnished. It shall be so utilized as to provide intermittent type gas-electric ignition and pre-ignition purge timer.

N. Discharge Louvers:

1. Adjustable horizontal and vertical louvers mounted within a welded frame shall be painted to match cabinet finish. Louvers will be shipped loose to be field installed.

2. Turning vanes will be factory installed in air discharge section of units. Substitutions to the basis of design manufacturer that do not provide turning vanes shall account for loss of air flow due to system effect by adding 0.25” of internal static pressure loss to their fan selections. Manufacture shall be responsible for any additional cost to do higher unit MCA/ MOCP to achieve scheduled air flow.

O. Controls:

1. There shall be a locking control cabinet with flame failure alarm horn, temperature controls, and displaying pilot lights to indicate "power on", and "call for heat" light indicator.

2. The power panel shall have a locking dead front main power cabinet with disconnect and containing necessary fuses, sub-circuits, magnetic starters with 3-leg protection, relays and contactors requiring only single 3-phase connection.

3. The control panel shall contain an emergency shutdown circuit that may be supervised by the fire protection system in the facility. At owner's option this can be accomplished with an external power source of either 120 volts or 24 volts.

4. Return air smoke detector - Non-addressable type.

5. Supply air smoke detector - Non-addressable type.

6. The unit shall incorporate factory-mounted transformers to step down the main power supply voltage to be 120 volts and 24 volts (as required).

7. Heating and Cooling thermostat/controls - via return air thermostat.

8. NEMA -3R rated outdoor power panel.

9. NEMA-1 indoor rated remote control panel with LCD display.

10. DDC type controller (Carel, or equivalent) provided by ARU manufacturer.

11. BAS Interface Card - BACNET/LON/MODBUS/Web capable.

12. Variable frequency drive - 1 per unit with manual controls, no bypass. Motors shall be inverter capable for use with VFD. Shaft grounding ring provided by ARU manufacturer.

13. Actuator power and control by ARU manufacturer, dry bulb economizer type.

14. Two high temperature limits shall be installed, one for automatic reset (factory set at 200°F) and one for manual reset (factory set at 250°F).

P. Accessories:

1. Air outlet extension(s), as required, to raise discharge level to 30’0”.

2. UL-approved double-wall flue piping with stainless steel liner (including penetration assembly and rain cap) provided by ARU manufacturer, ships loose.

3. Low leak outside air dampers with blade and jamb seals (Ruskin CD-60 or equivalent) sized for 100% outside air.

4. Low leak return air dampers with blade and jamb seals (Ruskin CD-60 or equivalent) sized for 100% return air.

5. 0-100% modulating dry-bulb economizer.

6. Belimo 24V modulating actuators to be provided, mounted and wired by ARU manufacturer at all damper openings.

7. Factory installed disconnect.

8. Filtered Outside air intake hood with bird screen.

9. Supply louver shipped loose for field installation.

10. Return grille shipped loose for field installation.

11. Freight to job site and factory-assisted start-up services shall be included with all bids.

Q. Markings

1. The unit nameplate contain unit model number, serial number, full load amps, and supply voltage

2. The units shall be permanently marked with the equipment number ARU-# as identified in the performance section.

3. All matching pieces of units shipped in sections shall be marked for easy identification of adjoining sections.

4. Proper warning labels for high voltage and moving parts shall be permanently affixed to access doors.

5. Inlet gas connection, gas vent connections and lifting points shall be marked.

6. An electrical ladder diagram shall be permanently affixed inside of the electrical control panel. The schematic shall be specific to the project and not be a generic type encompassing features or options not present on the unit. The schematic shall include the fuse replacement values and types.

R. Technical Field Service/Start-up:

1. The services of a factory trained Field Engineer will be provided at no extra cost to owner to supervise placing the system in operation and good adjustment. The Field Engineer will instruct the owner's personnel in good equipment operation, and review maintenance procedures with owner's qualified personnel or representatives.

2. The start-up shall include but not be limited to:

3. Verification of proper supply power and fuel.

4. Verification that electrical terminals are secure.

5. Proper Airflow balance.

6. Verification of combustion efficiency and proper burner adjustments

7. Testing of all safety and operating controls.

8. Setting of High and Low/Modulation fire.

PART 3 EXECUTION/INSTALLATION

3.1 Receive, set and assemble the unit complete with factory furnished interconnecting power connections between the load side of the power panel and the fan. Install fuel fired heater/furnaces, complete piping connections and provide required venting in accordance with unit manufacturer's recommendations. Submit manufacturer's printed installation instructions with operating and maintenance data at completion of work.

END OF SECTION

SECTION 23 23 00
REFRIGERATION PIPING SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping

B. Valves

C. Fittings

D. Filter-driers

E. Piping system accessories.

F. Refrigerant

1.2 RELATED REQUIREMENTS

A. Section 23 05 00 - Common Work Results for HVAC

B. Section 23 05 29 - (DO NOT USE) Hangers and Supports for HVAC Piping and Equipment

C. Section 23 07 00 - HVAC INSULATION

1.3 REFERENCE STANDARDS

A. Comply with the requirements of ANSI/ASHRAE Standard 15, Safety Standard for Refrigerant Systems

B. ASHRAE Standard 34 - Designation and Safety Classification of Refrigerants.

C. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

D. AHRI 750 - Standard for Thermostatic Refrigerant Expansion Valves

E. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers

1.4 SUBMITTALS

A. Provide manufacturers product data, piping diagrams and related information in accordance with the provisions of Division 01.

B. Submit for review manufacturer's product data for refrigerants and refrigerant piping system components.

1.5 REFRIGERANT

A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

B. Refrigerant: R-134a, tetrafluoroethane as defined in ASHRAE Std 34.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping: Type "L" ACR hard copper, ASTM B280.

B. Fittings: Wrought copper.

C. Solder: Silver solder, or phos-copper solder having a melting point of 1125 degrees F or higher.

D. Valves:

1. Manufacturers: Flomatic, Hanson Technologies Corp., or Henry Technologies.

2. Diaphragm Packless Valves:

a. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).

3. Packed Angle Valves:

a. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).

4. Ball Valves:

a. Two piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 300 degrees F (149 degrees C).

5. Service Valves:

a. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi (3450 kPa).

E. Solenoid Valves:

1. Manufacturers: Flow Controls (Emerson Climate Technologies), Parker Hannifin, or Sporlan Co.

2. AHRI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi (3450 kPa). Suitable for the type of refrigerant used.

F. Refrigerant Filter Dehydrator and Moisture Indicator

1. Dehydrator: Sporlan Co. Catch-All, or equal, with replaceable core, type, of size recommended by manufacturer for maximum design tonnage.

2. Moisture Indicator: Sporlan Co. See-All, type SA-125, or equal.

G. Pressure Regulators

1. Manufacturers: Hansen Technologies Corp., Parker Hannifin, or Sporlan Co.

2. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi (0 to 550 kPa) range, for maximum working pressure of 450 psi (3100 kPa).

H. Pressure Relief Valves

1. Manufacturers: Hansen Technologies Corp., Henry Technologies, or Sherwood Valve/Harsco Corp.

2. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi (1620 kPa).

I. Expansion Valves

1. Manufacturers: Flow Controls (Emerson Climate Technologies), Parker Hannifin, or Sporlan Co.

2. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.

3. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F (6 degrees C) superheat. Select to avoid being undersized at full load and excessively oversized at part load.

J. Electronic Expansion Valves

1. Manufacturers: Flomatic Valves, Parker Hannifin, or Sporlan Co.

2. Valve:

   a. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.

3. Evaporation Control System:

   a. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.

4. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

K. Receivers

1. Manufacturers: Henry Technologies, Parker Hannifin, or Sherwood Valve/Harsco Corp.

2. Internal Diameter 6 inch (150 mm) and Smaller:

   a. AHRI 495, UL listed, steel, brazed; 400 psi (2760 kPa) maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

3. Internal Diameter Over 6 inch (150 mm):

   a. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi (2760 kPa) with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

L. Flexible Connectors

1. Manufacturers: Circuit Hydraulics, Ltd., Flexicraft Industries, or Penflex

2. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches (230 mm) long with copper tube ends; for maximum working pressure of 500 psi (3450 kPa).

M. Check Valves

1. Manufacturers: Hansen Technologies Corp., Parker Hannifin, or Sporlan Co.

2. Globe Type:

   a. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, Teflon seat

disc; for maximum temperature of 300 degrees F (149 degrees C) and maximum working pressure of 425 psi (2930 kPa).

3. Straight Through Type:

a. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi (3450 kPa) and maximum temperature of 200 degrees F (93 degrees C).

N. Strainers

1. Straight Line or Angle Line Type:

a. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi (2960 kPa).

O. Pipe Supports:

1. Pipes subject to vibration: Isolation type brackets

2. Pipes not subject to vibration: Anvil No. CT-95 or equal

3. Riser clamps: Anvil CT-121 or equal

P. Escutcheons: Chrome plated escutcheons sized for pipe.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Make solder joints with carbon dioxide or nitrogen passing through joints being soldered. Insure a clean, tight system. Pull a clean rag through each piece of tubing after cutting or reaming.

B. Route piping in orderly manner, parallel or perpendicular to building structure, and maintain gradient.

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

D. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

E. Install refrigeration specialties in accordance with manufacturer's instructions.

F. Insulate piping and equipment.

G. Install pipe and hangers in accordance with hanger manufacturer's printed instructions.

3.2 LEAK TESTING

A. Test for leaks by use of carbon dioxide or nitrogen and a liquid soapsuds solution. Correct leaks found.

B. Pressurize system, with carbon dioxide or nitrogen, to 300 psig on the high side, and 200 psig on the low side, and test for leaks. Then test for leaks using a Halide leak detector. Correct leaks found.

C. Evacuate system and charge with specified refrigerant until the manufacturer's recommended operating pressure is reached.

3.3 SAFETY CODE

A. System shall be in accordance with ASHRAE STD 15, Safety Standard for Refrigeration Systems.

END OF SECTION

SECTION 23 31 13
SHEETMETAL DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Rectangular Metal Ducts

B. Duct Sealant Material

1.2 RELATED REQUIREMENTS

A. Division 07 - Firestopping

B. Division 09 - Painting and Coating

C. Section 23 01 30.51 - HVAC Air Duct Cleaning

D. Section 23 05 48 - (DO NOT USE) Vibration and Seismic Controls for HVAC

E. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

F. Section 23 07 00 - HVAC INSULATION

G. Section 23 31 14 - Sheetmetal - Special Ductwork

H. Section 23 33 00 - (DO NOT USE) Air Duct Accessories

I. Section 23 33 19 - Duct Silencers

J. Section 23 36 00 - (DO NOT USE) Air Terminal Units

K. Section 23 37 00 - Air Outlets and Inlets

1.3 REFERENCE STANDARDS

A. ASHRAE Handbook - Fundamentals; 2013.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2014.

D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.

E. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2012.

F. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association; 2014.

G. SMACNA 1972 - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012, 2nd Edition.

H. SMACNA 1966 - HVAC Duct Construction Standards; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

I. SMACNA 1767 - Kitchen Ventilation Systems and Food Service Equipment Fabrication & Installation Guidelines; 2001.

J. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

K. UL 1978 - Grease Ducts; Current Edition, Including All Revisions.

L. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. Submit material/product data in accordance with the provisions of Division 01.

B. Duct dimensions shown on drawings indicate inside clear dimensions. Make calculation allowances for duct requiring internal sound lining, or insulation to provide "inside clear" (IC) dimensions.

C. Shop Drawings: Provide shop drawings of sheet metal shop ductwork, as follows:

1. Draw to a scale not less than 1/4-inch to one foot

2. Provide sheet sizes equal to Contract Drawings

3. Show duct sizes

4. Show fitting details

5. Show lighting and ceiling diffusers

6. Show bottom of duct elevation above finished floor

7. Show all manual and motorized dampers and associated access doors.

8. Show HVAC equipment, all air terminal units, and air quantities.

D. Coordinated Shop Drawings: Provide coordinated shop drawings for sheet metal work in mechanical equipment rooms, and other congested areas listed.

1. Draw to a scale of 1/2 inch to 1 foot.

2. Provide sheet sizes to match Contract Drawings.

3. Show duct sizes.

4. Show bottom duct elevations from finished floor.

5. Show lighting, equipment, maintenance and operating clearances, plumbing piping, conduit 3" and larger, and columns and beams with mounting heights.

6. Show construction details of all fittings and connections to equipment.

7. Show construction details of plenums and casing.

E. Coordinated Shop Drawings shall be completed for all areas prior to installation of the major trades. The coordinated shop drawings are not required to be submitted except as noted above. A coordinated shop drawing attempt shall be submitted with any request to the owner or design team to assist with overhead coordination conflicts.

F. Certifications: Provide a duct schedule, certified by an officer of the sheet metal fabrication subcontractor, that the ductwork conforms to SMACNA standards. For each sheet metal system furnished on the project include:

1. System name

2. Duct material

3. Duct gauge

4. SMACNA rectangular reinforcement number

5. SMACNA intermediate reinforcement number

6. SMACNA transverse reinforcement number

7. Rod diameter and type

8. Sealant type and material by pressure classification

9. Attachment method

10. Duct system design pressure

G. Field Conditions

1. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturer.

2. Maintain temperature within acceptable range during and after installation of duct sealants.

1.5 QUALITY ASSURANCE

A. Provide an installed duct system which will supply the air quantities indicated by the drawings and have the lowest possible friction loss with the least possible leakage loss. System static pressure loss for each system shall not exceed that which is indicated in the equipment schedule as external static pressure or in the fan schedule as static pressure and shall include the losses of all accessories. Friction losses shall be minimized by reduction in the number of offsets and elbows by pre-planning the duct system installation and coordination with other trades to prevent interferences. Maintain access to accessories requiring maintenance, service, and inspection. Radius elbows are preferred for turns to minimize friction, noise, and vibrations.

B. Provide and/or construct materials, ductwork, joints, transformations, splitters, dampers, and access doors as specified herein for the sheet metal ductwork as shown on drawings.

C. SMACNA Manual: Sheet Metal Tradesman shall have access on the construction site to "HVAC Duct Construction Standards". Comply with applicable provisions of the SMACNA Manual and more stringent requirements of this specification.

D. Quality control involves not only the general performance requirements for air ducts, but also quality workmanship which includes layout pre-planning so that offsets, rises, falls, elbows, fittings, etc., are minimized or eliminated. General performance requirements for ducts include:

1. Dimensional stability (shape deformation and strength)

2. Containment of the air being conveyed (leakage control). See Part 3 of this specification for leakage testing.

3. Vibration (fatigue and appearance)

4. Noise (generation, transmission, or attenuation)

5. Exposure (to damage, weather, temperature extremes, flexure cycles, wind, corrosive atmospheres, biological contamination, flow interruption or reversal, underground or other encasement conditions, combustion, or other in-service conditions)

6. Support (alignment and position retention)

7. Seismic restraint

8. Thermal conductivity (heat gain or loss and condensation control)

E. Provide galvanized duct materials which meet applicable requirements of local and state codes, whichever is the most stringent.

F. Support ductwork in accordance with applicable requirements of local and state codes and details on drawings.

G. Emboss fittings with material gauge, manufacturer, and type material.

H. Sealers, liners, pre-insulated jackets and flexible ducts shall comply with a flame spread rating of 25 or less and a smoke developed rating of not over 50.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Sheet metal ductwork, angles, bar slips, hangers, and straps: Galvanized, prime quality steel sheets.

B. Screws: Cadmium plated.

C. Joint and Seam Sealers:

1. Acceptable Manufacturers:Carlisle Hard Cast Duct Sealants; Design Polymerics; Ductmate Industries; Childers (HB Fuller Construction Products).

2. Meets Seal Class A.

3. Water resistant, mold and mildew resistant

4. Suitable for indoor use and outdoor use with UV inhibitors.

5. Surface burning characteristics: Flame spread of zero and smoke developed of zero when tested in accordance with ASTM E84.

6. UL Listed and Labeled to UL181.

7. Suitable for metal duct, duct fabric and flex duct.

8. For Pressure Classifications 2" and less, indoors, use Carlisle Flex-Grip 550 for joints and seams.

9. For Pressure Classifications 3" and 4", indoors, use Carlisle Iron-Grip 601 for joints and seams.

10. For Pressure Classifications 6" to 10", indoors and outdoors, use fiber reinforced Carlisle Versa-Grip 181 for joints and seams.

11. For bolted duct joints and connections (Nexus, Ductmate, Elgen, TDC, TDF), use Ductmate DM440 Butyl Gasket Sealing Tape with Iron Grip 601 sealant at corner joints.

12. For all outdoor duct joints and seams, use Carlisle Versa-Grip 181, fiber reinforced with UV inhibitors, for all pressure classifications on all joints and seams.

13. For active live air flow systems, use Carlisle Aluma-Grip AFT-701, heavy-duty rolled mastic sealant on joints and seams.

14. Pressure sensitive foil tape is not acceptable and shall not be used as a duct joint sealer.

D. Duct Sealing:

1. All longitudinal and transverse joints, seams, taps, spin-ins, branch connections, access doors, access panels, duct connections to equipment and duct sidewall penetrations, regardless of pressure classification, shall be sealed with duct sealer. Follow SMANCA Table 1-2, Seal Class A for all supply, return, exhaust, relief, and make-up air ductwork.

2. See Leakage Testing of Installed Systems requirements in Part 3.

E. Sheetmetal and air duct accessories: As specified in Section 23 33 00.

2.2 PRESSURE CLASSIFICATION

A. Ductwork where maximum dimension is less than 97" shall be constructed based on applicable pressure classification in accordance with SMACNA Manual including sheetmetal gauge, reinforcement gauge and spacing.

B. Construct the following for 1" pressure classification, Table 1- 4:

1. Supply ductwork downstream of air terminal units

2. Low pressure supply ductwork to reheat coils

3. Low pressure supply, return, and outside air ductwork at fan coil units

C. Construct the following for 2" pressure classification, Table 1- 5:

1. Return ductwork

2. Exhaust ductwork

3. Make-up air ductwork

D. Construct the following for 6" w.g. pressure classification Table 1-8:

1. Supply ductwork and plenums downstream of supply fans up to air terminal units

2.3 RECTANGULAR DUCTWORK

A. Transverse Joints:

1. "S" and drive construction for 1" and 2" w.g. pressure classification.

a. Provide duct gauge and reinforcing angles in accordance with Table 1-11

2. Duct Connection System: Connection system as manufactured by Ductmate or Nexus shall incorporate gasketed joints, metal cleats and bolted corners. Minimum metal

gauge shall be 24 gauge. Connection systems may be used for all pressure classifications.

3. For pressure classifications above 2", use double "S" joint up to 30" and companion angle or manufacturer's connection system above 30".

B. Longitudinal Seams: Pittsburgh Lock

C. Transitions:

1. Do not exceed 1" in 7" of slope for increase-in-area transitions.

2. Do not exceed 1" in 4" of slope for decrease-in-area transitions, 1" in 7" is preferable.

3. Do not exceed 45 degrees on the entering or leaving side for angle of transitions at connections to equipment without the use of approved turning vanes.

D. Elbows:

1. Fabricate ells using one of the following specifications: The fabrication methods are listed in order of preference. Use radius elbows where ever possible. Use square elbows only when available space prevents the use of radius elbows.

a. Unvaned, long radius elbow with the throat radius equal to 3/4 of the width of the duct and with a full heel radius.

b. Six inch throat radius with full radius, single thickness vanes and full heel radius. Maximum unsupported length of vanes shall be 36". Securely fasten vanes to runners. Secure vanes in stable position. Construct vane edges to project tangents parallel to duct sides.

c. Square elbows with airfoil, double thickness turning vanes.

2. Turning vanes:

a. Acceptable manufacturers: Aero Dyne

b. Substitutions: Not permitted.

c. True airfoil design; smoothly-rounded entry nose with extended trailing edge. Generated sound power level shall not exceed 54 decibels in band 4 at 2000 FPM in a 24"x24" duct.

d. Fabricate assemblies with Aero Dyne Co. side rails; install vanes on design centers of 2.4 inches across the full diagonal dimension of the elbow.

e. Submit Aero Dyne product and performance data for review.

E. Branch Connections:

1. Pressure classification 2" and less:

a. Rectangular branch from rectangular main: 45 degree entry with all corners closed as shown in Figure 2-8

b. Round branches: Spin-in fitting without scoop.

c. Parallel flow branches: See Figure 2-7.

d. Space duct joints to avoid cutting them for branch take offs and outlet collars.

2. Pressure classification above 2":

a. Round branches: Conical round fittings only.

b. Rectangular branch from rectangular main: 45 degree entry with all corners closed as shown in Figure 2-8

c. Parallel flow branches: See Figure 2-7.

d. Space duct joints to avoid cutting them for branch take offs and outlet collars.

PART 3 - EXECUTION

3.1 INSTALLATION, APPLICATION, ERECTION

A. Do not exceed 45 degrees for easement transition angle.

B. Seal all transverse and longitudinal joints and seams and duct wall penetrations with approved sealer in accordance with manufacturer's directions regardless of pressure class.

C. Counterflash ductwork penetrating roof.

D. Support round ducts from building structure with galvanized steel hangers in accordance with SMACNA. Secure hangers to masonry portion of building by means of inserts or other acceptable anchors.

E. Secure hangers to steel structure members by means of C-clamps. Vertical risers, and other duct runs where methods of support specified above are not applicable, shall be supported by angle brackets as shown in SMACNA manual.

F. Where appropriate based on duct weight, support rectangular ducts by minimum, 1" x 18 gauge, galvanized band iron or minimum 3/8" galvanized rod hangers attached to reinforcing angles and spaced same as reinforcing angles. Design hangers, reinforcing angles and other components to support weight of duct and insulation. Secure hangers to concrete beam or slab by adequately sized inserts, anchor shield and bolt, toggle bolt, or expansion bolt.

G. Attach hangers to ductwork using sheet metal screws.

H. Space hangers approximately 8' along the duct for ducts under 60". For ducts over 60" and larger and heavier sections, such as welded duct and sound absorbers, space hangers at approximately 4' intervals.

I. Hangers and bracing used with ductwork shall be galvanized.

J. Provide smooth insulation finish around damper operating quadrants, splitter adjusting clamps, access doors, and similar operating devices. Provide metal collar equivalent in depth to insulation thickness. Access door locks and damper handles shall be free from mastic or sealant.

K. In addition to the requirements above, add supplemental bracing as necessary to prevent sagging and drumming, and/or vibration.

3.2 CLEANING

A. Clean mechanical system thoroughly to assure all foreign matter and dirt is removed.

3.3 AIR MOVING EQUIPMENT OPERATION DURING CONSTRUCTION

A. The use of new or existing air handling units, fans, or other permanent air moving equipment during construction is prohibited unless approved by the owner in writing. If approved for use during construction, the following procedures shall be followed:

1. The contractor shall protect the interior of all ductwork, air handling units, and other equipment from the accumulation of dirt and dust and other contaminants. If the permanent equipment cannot be adequately protected, temporary air moving/ conditioning equipment and distribution systems shall be utilized as required for finishing trades.

2. Provide all specified filters in equipment to be operated as well as temporary filters on all return and exhaust air grilles, open ductwork, and transfer openings in the work area.

3. The contractor shall remove all filters used during construction and replace them with new filters prior to test and balance work and prior to substantial completion.

4. If the ductwork and/or equipment is found to be contaminated at any point during construction, an independent NADCA certified contractor shall be retained to clean the ductwork and/or equipment at the contractors expense. Refer to Section 23 01 30.51.

5. System operating temperatures shall be maintained to avoid condensation on ductwork and equipment surfaces. New or existing insulation found damaged shall be replaced.

6. Coordinate use of air handling equipment with ICRA plan, if applicable. Maintain required pressure relationships in construction areas adjacent to occupied areas.

3.4 LEAKAGE TESTING OF INSTALLED SYSTEMS

A. Ductwork shall be pressure tested by HVAC Test and Balance Contractor. Refer to Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

B. Test duct for leakage in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Use prescribed test kit containing test blower, two U-tube manometers and calibrated curve attached to the orifice tube assembly.

C. Pressure testing shall include taps/take-offs to air terminal units in medium pressure ductwork and taps/take-offs to air devices in supply, return, and exhaust ductwork.

D. Pressurize all installed duct systems for each pressure class to maximum pressure for fabrication classification. The leakage amount shall not exceed the allotted amount for the pressure class or the allotted amount for that portion of the system as follows:

1. 1" Pressure Class - Leakage Class 6; Max. Leakage Factor - 6.0 CFM/100 SF

2. 2" Pressure Class - Leakage Class 6; Max. Leakage Factor - 9.4 CFM/100 SF

3. 4" Pressure Class - Leakage Class 3; Max. Leakage Factor - 7.4 CFM/100 SF

4. 6" Pressure Class - Leakage Class 3; Max. Leakage Factor - 9.6 CFM/100 SF

E. All ductwork shall be leak tested first before being enclosed in a shaft or above other inaccessible areas.

F. Correct leaks found in excess of allowable limits. Retest until acceptable leakage is witnessed.

G. Have test results available for review on a progressive and final basis. Include all test results in project closing file along with name, signature, and date of independent witness to testing. Test results shall show preliminary and final test results and include all calculations used to determine system compliance with the maximum specified leakage rate.

3.5 AIR TEST AND BALANCE

A. Prepare the system for tests as specified in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC and correct deficiencies found by the Test and Balance firm.

B. Duct dimensions shown on drawings indicate inside clear dimensions. Make calculation allowances for duct requiring internal sound lining, or insulation to provide "inside clear" (IC) dimensions.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Backdraft dampers - metal.

B. Duct access doors.

C. Duct test ports.

D. Fire dampers.

E. Smoke dampers.

F. Combination fire and smoke dampers.

G. Flexible duct

H. Flexible duct connections.

I. Volume control dampers.

1.2 RELATED REQUIREMENTS

A. Division 07: Firestopping.

B. Section 23 05 48 - (DO NOT USE) Vibration and Seismic Controls for HVAC.

C. Section 23 31 13 - Sheetmetal Ductwork.

D. Section 23 36 00 - (DO NOT USE) Air Terminal Units: Pressure regulating damper assemblies.

1.3 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.

B. SMACNA 1966 - HVAC Duct Construction Standards; 2005.

C. UL 181 - Factory-Made Air Ducts and Air Connectors; 2013.

D. UL 33 - Heat Responsive Links for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

E. UL 555 - Standard for Fire Dampers; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

F. UL 555S - Standard for Leakage Rated Dampers for Use in Smoke Control Systems; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

G. AMCA 511 - Certified Ratings Program-Product Rating Manual for Air Control Devices; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. Provide product data and information in accordance with the provisions of Division 01.

B. Product Data: Submit manufacturer's product data for review. Include electrical characteristics and connection requirements where applicable.

C. Project Record Drawings: Record actual locations of volume dampers, rated dampers, access doors, and test holes.

PART 2 - PRODUCTS

2.1 BACKDRAFT DAMPERS - METAL

A. Acceptable manufacturers: Louvers & Dampers, Nailor Industries, or Ruskin Company.

1. Substitutions: Refer to Division 01.

B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch (150 mm) 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; counter-balance adjustment device to permit setting for varying differential static pressure.

C. Damper and blade material shall be of the same material as the duct in which it is installed.

2.2 FIRE DAMPERS

A. Acceptable manufacturers: Air Balance, Greenheck, Ruskin, Nailor, or Pottorff

B. Fabricate in accordance with NFPA 90A, UL 555, and as indicated.

C. Material: Galvanized steel or 304 stainless steel to match adjacent ductwork.

D. Dampers shall be of stainless steel material where required for corrosion protection, non-ferrous construction, moisture laden ducts and high humidity applications.

E. Dampers shall be curtain or multi-blade type, 1-1/2 hour rated, suitable for horizontal or vertical mounting. Blades for curtain type dampers shall be stored out of the airstream.

F. Dampers shall be dynamic rated for closure against airflow up to 2000 FPM in low pressure systems and up to 4000 FPM in medium pressure systems.

G. Dampers shall have a UL 555 differential pressure rating of 4 in. wg.

H. Provide damper with fusible link causing the damper to lock in the closed position at 165 degrees F.

I. Provide manufacturer's round to horizontal duct adapter as required.

J. Maximum pressure drop shall be as follows:

1. Damper pressure drop shall not exceed 0.05 in. w.g. at 1500 FPM or 0.10 in w.g. at 2000 FPM.

K. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511.

2.3 SMOKE DAMPERS

A. Acceptable manufacturers: Air Balance, Greenheck, Ruskin, Nailor, or Pottorff

B. Fabricate in accordance with NFPA 90A, UL 555S, and as indicated.

C. Dampers: Single or multi-blade type with airfoil blades, automatically operated by 120V electric actuator mounted outside the airstream unless noted otherwise. Actuator shall be adequately sized to open the damper within 15 seconds. Blades in low velocity/low pressure applications may be of the triple vee-groove type conforming to the air pressure drop criteria and leakage requirements.

D. Dampers shall be Class 1 leakage rated and be dynamic rated for closure against airflow up to 2000 FPM in low pressure systems and up to 4000 FPM in medium pressure systems and at elevated temperatures of 250 degrees F minimum. Blade seals shall be silicone rubber.

E. Provide two-position actuator. Damper shall fail normally closed.

F. Provide each damper with an end switch to relay damper open/closed position.

G. Provide each damper with a remote test switch installed above the ceiling, accessible and adjacent to the damper.

H. Provide manufacturer's round to horizontal duct adapter as required.

I. Damper pressure drop shall not exceed 0.15 in. w.g. at 1500 FPM or 0.25 in. w.g. at 2000 FPM.

J. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511.

K. Where required by the installation and service, stainless steel smoke dampers shall be installed for corrosion protection, non-ferrous construction, moisture laden ducts and high humidity applications.

2.4 COMBINATION FIRE AND SMOKE DAMPERS

A. Acceptable manufacturers: Air Balance, Greenheck, Ruskin, Nailor, or Pottorff

B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

C. Dampers: Single or multi-blade type with airfoil blades, 1-1/2 hour rated, automatically operated by 120V electric actuator mounted outside the airstream unless noted otherwise. Actuator shall be adequately sized to open the damper within 15 seconds.

D. Dampers shall be Class 1 leakage rated and be dynamic rated for closure against airflow up to 2000 FPM and 4" w.g. in low pressure systems and up to 4000 FPM and 6" w.g. in medium pressure systems and at elevated temperatures of 250 degrees F minimum. Blade seals shall be silicone rubber.

E. Provide two-position actuator and with resetable link with open/closed indicator causing the damper to close at 165 degrees F. Damper shall fail normally closed.

F. Provide each damper with an end switch to relay damper open/closed position.

G. Provide each damper with a remote test switch installed above the ceiling, accessible and adjacent to the damper.

H. Provide manufacturer's round to horizontal duct adapter as required.

I. Damper pressure drop shall not exceed 0.15 in. w.g. at 1500 FPM or 0.25 in. w.g. at 2000 FPM.

J. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511.

K. Where required by the installation and service, stainless steel fire smoke dampers shall be installed for corrosion protection, non-ferrous construction, moisture laden ducts and high humidity applications.

2.5 SLEEVES FOR RATED DAMPERS

A. Unless otherwise required by the authority having jurisdiction, sleeves for fire dampers, smoke dampers and combination fire and smoke dampers shall be provided by the damper manufacturer and be of rigid type construction recommended in SMACNA Publication for "Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems", Fifth Edition. Install dampers in minimum 20 GA. sleeves, or thicker if required by duct size or UL Listing. Provide minimum 18" long sleeves. Coordinate required sleeve length with wall and floor thickness and U.L. Listing for damper type and installation.

B. Duct connections to sleeves shall be of the breakaway type.

C. Install 1-1/2"x1-1/2"x 16 GA. minimum angles on four sides of sleeves and both sides of wall. Fasten angles to sleeve only. Do not fasten to the wall.

2.6 DUCT ACCESS DOORS

A. Acceptable manufacturers: Ruskin, SEMCO, Greenheck, Ward Industries, or DuctMate.

   1. Substitutions: Refer to Division 01.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

C. Duct access doors shall have a leakage classification ratings of 3" w.g. positive and 2" w.g. negative for duct construction of 2" and less. Duct access doors shall have a leakage classification rating of 10" w.g. positive and 10" w.g. negative for duct construction of 4" w.g. and greater.

D. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, provide minimum 1 inch (25 mm) thick insulation with minimum 24 gauge sheet metal cover on each side.

   1. Less Than 12 inches (300 mm) Square: Secure with sash locks.

   2. Up to 18 inches (450 mm) Square: Provide two hinges and two sash locks.

   3. Up to 24 x 48 inches (600 x 1200 mm): Three hinges and two compression latches with outside and inside handles.

   4. Larger Sizes: Provide an additional hinge.

   5. Latches shall permit easy removal of access door while maintaining positive closing and minimum leakage. Provide continuous sponge rubber gaskets for all doors.

E. Provide insulated doors in ductwork for access to service equipment such as airflow measuring stations (each side), casing mounted coils (each side), control dampers, duct mounted coils (each side), duct mounted smoke detectors, humidifiers, rated dampers, and elsewhere as noted on drawings.

F. Size access doors as follows:

   1. Duct sizes under 12": Door sized sufficient to service equipment or replace fusible link.

   2. Duct sizes 12" to 20": 12"x12" door.

   3. Duct sizes 20" to 36": 18"x18" door.

   4. Duct sizes above 36": 24"x24" door.

G. Provide reinforced wire glass view windows (min. 12"x12") in access doors at humidifiers.

H. Mount doors in rigid frame of at least 22 gauge formed galvanized steel or aluminum.

I. Use angle iron bracing as required to make the door frame a rigid assembly.

J. In accordance with NFPA 90A, identify each access door with minimum 1/2" high printed or stenciled letters as 'Fire Damper', 'Smoke Damper', or 'Combination Fire/Smoke Damper'.

2.7 DUCT TEST PORTS

A. Temporary Test Port: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps. Repair insulation and vapor barrier.

B. Permanent Test Port: Factory fabricated, air tight flanged fittings with screw cap equal to Carlisle PTP-1. Provide extended neck fittings to clear insulation.

2.8 FLEXIBLE DUCT

A. Acceptable manufacturers: Thermaflex M-KE

1. Substitutions: Refer to Division 01.

B. Characteristics of flexible duct to air terminals:

1. Approved as UL 181 Class 1 air duct with a minimum rated air velocity of 4,000 feet per minute and pressure rated for a minimum of 4-inches water gauge positive pressure and 1-inch water gauge negative pressure.

2. Composed of a Chlorinated Polyethylene (CPE) liner duct permanently bonded to a coated spring steel wire helix.

3. Fire-retardant, low permeability outer vapor barrier of fiberglass reinforced film laminate with a permanence of not greater than 0.05 perms when tested in accordance with ASTM E 96 Procedure A.

4. Flame spread less than 25, smoke developed rating less than 50.

5. Insulated with 1/2" thick fiberglass insulation.

6. Provide a minimum of three feet of flexible duct upstream of diffusers. Do not exceed six feet of length.

7. Flexible duct shall meet standards of local building code.

8. The duct shall have passed an impact test equal to the UL 181 standard, conducted by a nationally recognized testing laboratory except it shall use a 25-pound weight dropped from a height of 10 feet. The inner and outer surfaces shall not have ruptured, broken, torn, ripped, collapsed or separated. The helix shall rebound to a cross-sectional elliptical area not less than 80 percent of the original test sample diameter.

C. The use of flex duct shall be limited to flexible air connector applications.

D. Seal off the insulation jacket at its ends and at joints with mastic, hardcast, or similar material. Replace flex if jacket is punctured.

E. Complete insulation coverage up to the diffuser neck connection.

F. Do not route flexible duct through corridor walls or fire or smoke rated partitions, barriers, or walls.

G. No bends shall be made in flexible duct with the center line radius less than one and one-half duct diameter and only one bend may occur per four foot length of duct material.

2.9 FLEXIBLE DUCT CONNECTIONS

A. Acceptable manufacturers: Carlisle, Durodyne, Elgen, or DuctMate.

1. Substitutions: Refer to Division 01.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

C. Flexible Duct Connections: Fabric crimped into metal edging strip with 10" w.g. positive and negative pressure rating.

1. Fabric: NFPA 90A compliant, UL listed fire-retardant neoprene coated woven glass fiber fabric, minimum 28 oz. density.

a. Net Fabric Width: Approximately 3 inches (75 mm) wide.

2. Metal: 3 inches (75 mm) wide, 24 gauge, 0.0239 inch (0.61 mm) thick galvanized steel. Provide aluminum or stainless steel metal as required to match ductwork material.

2.10 VOLUME CONTROL DAMPERS

A. Acceptable manufacturers: Louvers & Dampers, Greenheck, McGill Airflow, Ruskin, or SEMCO.

1. Substitutions: Refer to Division 01.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.

C. Damper and blade material shall be of the same material as the duct in which it is installed.

D. Where manual or motorized volume dampers and control dampers are installed in outside air ducts in coastal climates subject to salt air, provide dampers of aluminum construction with appropriate supports and handles.

E. Splitter Dampers:

1. Material: Same gauge and material as duct to 24 inches (600 mm) size in either direction, and two gauges heavier for sizes over 24 inches (600 mm).

2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.

3. Operator: Minimum 1/4 inch (6 mm) diameter rod in self aligning, universal joint action, flanged bushing with set screw .

F. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch (150 x 760 mm).

1. Fabricate for duct sizes up to 6 x 30 inch (150 x 760 mm).

2. Blade: 22 gauge, minimum.

3. Frame: 18 gauge, minimum.

G. Multi-Blade Damper: Fabricate of opposed blade pattern with 3V or airflow shaped blades and maximum blade sizes 8 x 72 inch (200 x 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

1. Blade: 18 gauge, 0.0478 inch (1.21 mm), minimum.

H. End Bearings: Except in round ducts 12 inches (300 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

I. Quadrants:

1. Provide locking, indicating quadrant regulators on multi-blade dampers.

2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

3. Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in locations specified and as shown on drawings in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards. Refer to Section 23 31 13 for duct construction and pressure class.

B. Provide insulated doors in ductwork for access to service equipment such as airflow measuring stations (each side), casing mounted coils (each side), control dampers, duct mounted coils (each side), duct mounted smoke detectors, humidifiers, rated dampers, and elsewhere as noted on drawings.

C. Provide insulated access doors in kitchen exhaust ducts for cleaning and inspection in accordance with NFPA 96.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges. Install in accordance with manufacturer's written requirements and UL Listing.

F. At fans and motorized equipment associated with ducts, provide flexible duct connections between equipment discharge and adjoining ductwork or plenum.

G. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

H. Provide balancing dampers at all points on supply, return, and exhaust systems where branches are taken from larger ducts.

I. Use splitter dampers only where indicated.

J. Where diffusers or grilles and registers are not provided with volume dampers, install spin-in fitting with balance damper in duct run-out.

K. Provide all screws, bolts, nuts, inserts, and material required for attaching sheetmetal to duct, walls, floors, and ceilings.

3.2 TESTING

A. Check work for satisfactory installation and performance.

B. Insure that adequate access does in fact exist for rated dampers, that damper blade movement is not restricted, and that damper operator motors are not hindered in operation by proximity to walls or other objects.

C. Check damper end switches to confirm they are functional per the HVAC sequence of operation.

D. Check duct connections at access doors for air leakage or condensation. Correct deficiencies found.

END OF SECTION

SECTION 23 34 18
CENTRIFUGAL EXHAUST FANS - ROOF AND WALL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Roof Mounted Centrifugal Fans

B. Wall Mounted Centrifugal Fans

1.2 RELATED REQUIREMENTS

A. Section 23 05 00 - Common Work Results for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 - Vibration and Seismic Controls for HVAC

D. Division 26: Electrical

1.3 REFERENCE STANDARDS

A. AMCA 99 - Standards Handbook

B. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating

C. AMCA 211 - Certified Ratings Program - Product Rating Manual for Fan Air Performance

D. AMCA 300 - Reverberant Room Method for Sound Testing of Fans

E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data

F. AMCA 311 - Certified Ratings Program - Product Rating Manual for Fan Sound Performance

G. ANSI/ABMA Standard 9 - Load Ratings and Fatigue Life for Ball Bearings

1.4 SUBMITTALS

A. Submit manufacturer's product data for review in accordance with the provisions of Division 01..

B. Fan curves shall include entire range of RPM curves, scheduled operating point, brake horsepower, motor horsepower, and sound performance data.

1.5 QUALITY ASSURANCE

A. Certify fans performance in accordance with AMCA Certified Air and Sound Rating Criteria, Standards 210, 211, and 301.

B. Sound Power data: Rated in accordance with AMCA 300.

C. All fans shall bear the AMCA Certified Ratings Program seal for Air and Sound Performance.

D. All fans shall bear the AMCA Certified Ratings Program seal for Fan Energy Index (FEI).

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data as specified in Division 01.

B. Include instructions for lubrication, motor, spare parts list, and wiring diagrams.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Protect motors, shafts, and bearings from weather and construction dust.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acme, Carnes, Greenheck, Jenco, Loren Cook, or PennBarry.

B. Substitutions: Refer to Division 01.

2.2 ROOF MOUNTED FANS

A. Drives: Variable pitch V-belt drives or direct driven as scheduled.

B. Housings: Hinged, heavy gauge aluminum enclosing motor outside airstream.

C. Motor: Ball bearing type, designed for heavy duty vertical and horizontal mounting. Isolate motors and fans from base with rubber isolators. Select motor such that motor BHP does not exceed nameplate at rated conditions.

D. Fans: Centrifugal type, statically and dynamically balanced.

E. Provide:

1. Lubricated lifetime sealed ball bearings.

2. Spark proof constructions with explosion proof motor suitable for Class I, Group C, Division 33 service, where scheduled on drawings.

3. Gravity dampers where not specified to be motorized.

4. Motorized backdraft dampers interlocked as shown in control drawings.

5. Disconnect switch on 3-phase units furnished under Division 26, unless noted as a fan accessory on fan schedule.

6. Bird screen around fan discharge.

7. Where required, prefabricated, 1" thick fiberglass insulated, roof curb of same material as fan housings and manufactured by the fan manufacturer. Provide minimum 18" high curb; see Mechanical Schedules on drawings.

8. Refer to architectural drawings or existing conditions for roof pitch.

9. Upblast housing where shown on drawings.

2.3 WALL MOUNTED FANS

A. Fan Housing: Removable heavy gauge spun aluminum enclosing motor outside airstream.

B. Isolate fans and motor from base with rubber vibration isolators. Select fan such that BHP does not exceed nameplate horsepower at rated conditions.

C. Fans: Centrifugal type, statically and dynamically balanced.

D. Provide:

1. Lubricated lifetime sealed ball bearings.

2. Spark proof constructions with explosion proof motor suitable for Class I, Group C, Division 2 service, where scheduled on drawings.

3. Gravity dampers where not specified to be motorized.

4. Motorized backdraft dampers interlocked as shown in control drawings.

5. Disconnect switch on 3-phase units furnished under Division 26, unless noted as a fan accessory on fan schedule.

6. Bird screen around fan discharge.

PART 3 - EXECUTION

3.1 ROOF MOUNTED FANS

A. Secure fans to curbs with stainless steel screws and fasteners..

B. Connect duct to fans to allow for straight and smooth airflow.

C. Provide flexible connections (minimum of 4") between fan and duct.

D. Install fan level - plus or minus 5 degrees in vertical. Final installation to be free of all leaks both from fan interior and roof-to-curb interface.

3.2 WALL MOUNTED FANS

A. Install fans in accordance with manufacturer's published installation instructions.

B. Connect and test electrical connections under Division 26.

3.3 START-UP, TESTING, DEMONSTRATION

A. Start-up fans after checkout to ensure proper alignment and phased electrical connections.

B. Test fans individually and as part of a system, where required, in accordance with Section 23 05 00 - Common Work Results for HVAC.

C. Where required, ensure that fans are interlocked with supply and/or return fans and with fire detection and control system.

D. Demonstrate and instruct operation to maintenance personnel.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/grilles.

C. Louvers and Louvered Penthouses.

1.2 RELATED REQUIREMENTS

A. Section 23 05 00 - Common Work Results for HVAC

B. Section 23 33 00 - Air Duct Accessories

C. Section 23 31 13 - Sheetmetal Ductwork

D. Section 23 31 14 - Sheetmetal - Special Ductwork

1.3 SUBMITTALS

A. Product Data: Submit product data for review in accordance with the provisions of Division 01. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

B. Samples: Submit two of each required air outlet and inlet type upon request.

C. Project Record Documents: Record actual locations of air outlets and inlets.

1.4 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ASHRAE STD 70.

B. Test and rate louver performance in accordance with AMCA 500-L.

C. All louvers shall bear the AMCA Certified Ratings Program seal for Air Performance.

D. All louvers shall bear the AMCA Certified Ratings Program seal for Air Performance, Water Penetration and Wind Driven Rain.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Anemostat, Carnes, Krueger, Metalaire, Nailor, Price, or Titus unless noted otherwise.

B. Substitutions: Refer to Division 01.

C. Air devices shall meet these specifications and the requirements noted in the Air Distribution Device Schedule. Titus model numbers are not inclusive of all listed requirements.

D. Ceiling diffusers, grilles and registers shall be of steel construction when installed in a fire rated floor/ceiling or roof/ceiling assemblies as detailed in the UL Fire Resistance Index.

2.2 SUPPLY DIFFUSERS

A. Type S1 (based on Titus TMS)

1. Square, 3-cone louvered face ceiling diffuser, four way directional blow. For diffusers noted on drawings to be 2 or 3 way blow, provide blank off plates in diffuser. Provide panel, face and neck size scheduled.

2. Material: Steel with baked acrylic finish.

3. Color: White.

4. Borders and mounting: Coordinate ceiling device frame type with architectural ceiling type. Where panel size is smaller than lay-in tile size, use surface mount frame and locate in center of tile. Maintain tile size consistent with other tiles in space.

5. Dampers: Provide ceiling diffusers complete with opposed blade volume dampers where diffuser is installed in inaccessible ceiling and spin-in fitting manual volume damper at branch ductwork tap is not accessible.

6. Accessories: None.

B. Type S0 (based on Titus TDC)

1. Square, multi-cone louvered face diffuser, four way directional blow. Diffuser louvers shall be flush with ceiling. For diffusers noted on drawings to be 2 or 3 way blow, provide blank off plates in diffuser. Provide panel, face and neck sized scheduled.

2. Material: Steel with backed acrylic finish.

3. Color: White.

4. Borders and mounting: Coordinate ceiling device frame type with architectural ceiling type. Where panel size is smaller than lay-in tile size, use surface mount frame and locate in center of tile. Maintain tile size consistent with other tiles in space.

5. Dampers: Provide ceiling diffusers complete with opposed blade volume dampers where diffusers is installed in inaccessible ceiling and spin-in fitting manual volume damper at branch ductwork tap is not accessible.

6. Accessories: None

C. Type S2 (based on Titus ML-39)

1. Linear diffuser with 1" slot(s) and shaped steel pattern controllers in each slot capable of 180 degree pattern adjustment. Refer to schedule for length and slot quantity. Multiple sections of diffusers shown end-to-end shall be joined together with alignment pins to form a continuous slot appearance. Provide heavy gauge aluminum end borders, end caps, and mitered corners to close off ends of diffusers.

2. Material: Aluminum with baked acrylic finish.

3. Color: White face with black pattern controllers.

4. Borders and mounting: Coordinate ceiling device frame type with architectural ceiling type. Sidewall mounted diffusers shall be installed so the fastening devices are not visible from the finished space.

5. Dampers: Refer to Construction Drawings.

6. Accessories: Plenum by the same manufacturer and meeting the performance requirements scheduled. Plenum shall be externally field insulated with 1/2" thick fiberglass.

D. Type S3 (based on Titus PAS)

1. Square, perforated face diffuser with 3/16" diameter holes on 1/4" staggered centers and no less than 51% free area. Provide with adjustable pattern controller to allow field adjustment of vertical, one, two, three, or four way directional blow. Perforated face must be easily un-latchable from the backpan for pattern controller adjustment and access to damper, when present. Provide panel, face and neck size scheduled.

2. Material: Steel with baked acrylic finish.

3. Color: White.

4. Borders and mounting: Coordinate ceiling device frame type with architectural ceiling type.

5. Dampers: Provide ceiling diffusers complete with opposed blade volume dampers where diffuser is installed in inaccessible ceiling and spin-in fitting manual volume damper at branch ductwork tap is not accessible.

6. Accessories: None.

E. Type S5 (based on Titus 300R)

1. Sidewall, double deflection register with 3/4" blade spacing and front blades parallel to the long dimension. Blades shall have steel friction pivots on both ends to allow individual blade adjustment without loosening or rattling. Provide panel, face and neck size as scheduled.

2. Material: Steel with baked acrylic finish.

3. Color: White.

4. Borders and mounting: 1-1/4" wide border on all sides with countersunk screw holes..

5. Dampers: Provide opposed blade manual volume damper with matching finish behind register. Damper shall be adjustable through the front blades of the diffuser.

6. Accessories: None.

2.3 RETURN AND EXHAUST GRILLES

A. Type R1 / E1 (based on Titus 50F)

1. Square or rectangular frame with perforated 1/2" x 1/2" x 1/2" grid. Provide frame and face size scheduled with minimum 3" deep fabricated steel backpan with centered ductwork connection equal to neck size scheduled. The visible surface of the backpan shall be painted flat black, unless noted otherwise. Provide panel, face and neck size scheduled.

2. Material: Aluminum frame and grid with baked acrylic finish.

3. Color: White.

4. Borders and mounting: Coordinate ceiling device frame type with architectural ceiling type.

5. Dampers: Provide ceiling grille complete with opposed blade volume dampers where diffuser is installed in inaccessible ceiling and spin-in fitting manual volume damper at branch ductwork tap is not accessible.

6. Accessories: None.

B. Type R2 / E2 (based on Titus MLR-39)

1. Linear grille with 1" slot(s). Refer to schedule for length and slot quantity. Multiple sections of grilles shown end-to-end shall be joined together with alignment pins to form a continuous slot appearance. Provide heavy gauge aluminum end borders, end caps, and mitered corners to close off ends of grilles. Provide factory fabricated, flat black blank off plates for unused portions of continuous grille. Provide panel, face and neck size scheduled.

2. Material: Aluminum with baked acrylic finish.

3. Color: White

4. Borders and mounting: Coordinate ceiling device frame type with architectural ceiling type. Sidewall mounted diffusers shall be installed so the fastening devices are not visible from the finished space.

5. Dampers: Refer to Construction Drawings.

6. Accessories: Plenum by the same manufacturer and meeting the performance requirements scheduled. Plenum shall be non-insulated.

C. Type R3 / E3 (based on Titus PAR)

1. Square or rectangular, perforated face grille with 3/16" diameter holes on 1/4" staggered centers and no less than 51% free area. Provide frame and face size scheduled with minimum 3" deep fabricated steel backpan with centered ductwork connection equal to neck size scheduled. The visible surface of the backpan shall be painted flat black, unless noted otherwise. Perforated face must be easily un-latchable from the backpan. Provide panel, face and neck size scheduled.

2. Material: Steel with baked acrylic finish.

3. Color: White.

4. Borders and mounting: Coordinate ceiling device frame type with architectural ceiling type.

5. Dampers: Provide ceiling grille complete with opposed blade volume dampers where diffuser is installed in inaccessible ceiling and spin-in fitting manual volume damper at branch ductwork tap is not accessible.

6. Accessories: None.

D. Type R5 / E5 (based on Titus 355RL)

1. Sidewall grille with 35 degree fixed deflection blades spaced 1/2" apart. Refer to schedule for blade orientation. Provide face and neck size scheduled.

2. Material: Steel with baked acrylic finish.

3. Color: White.

4. Borders and mounting: 1-1/4" wide border on all sides with countersunk screw holes..

5. Dampers: Provide opposed blade manual volume damper with matching finish behind register. Damper shall be adjustable through the front blades of the grille.

6. Accessories: Provide with piano hinged 1" filter frame and quarter turn fastener when noted on drawings. Hinge shall be located on right or left side of grille as required to allow frame door to fully open.

E. Type R6 (based on Titus PAR)

1. Same as Type R3 without backpan for use in open return plenums. Refer to Type R3 specifications for product requirements. Provide panel, face and neck size scheduled.

F. Type R7 (based on Titus 50F)

1. Same as Type R1 without backpan for use in open return plenums. Refer to Type R1 specifications for product requirements. Provide panel, face and neck size scheduled.

2.4 LOUVERS AND LOUVERED PENTHOUSES

A. Acceptable manufacturers for Louvers

1. Airolite, Construction Specialties, Dowco Corporation - Model DBE-04 or DBE-06, Louvers and Dampers, Inc., Penn Airstream - Model M44 or M63, or Ruskin - Model ELF-375D or ELF-6375D.

2. Substitutions: Refer to Division 01.

B. Acceptable manufacturers for Louvered Penthouses

1. Airolite, Construction Specialties, Louvers and Dampers, Inc., or Ruskin

2. Substitutions: Refer to Division 01.

C. Verify size, location, and placement of louvers prior to fabrication; coordinate field measurements and shop drawings and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Louver depth should match wall thickness.

D. Preassemble louvers in sections as large as practical.

E. Material: Extruded aluminum with 12 gauge, .081" thick aluminum frame with 0.063" minimum thickness blades and welded construction.

F. Blade angle: Minimum 35 degrees from horizontal.

G. Use blades minimum 4" or 6" deep, blades to match wall thickness, with drain gutter on each blade and downspouts in jams and mullions.

H. Set blades on 3" or 4-1/2" centers.

I. Provide internally braced corners with caulking slots.

J. Provide interlocked mullions with a provision for expansion and contraction.

K. Design structural supports to carry a wind load of not less than 20 pounds per square foot.

L. Louvered penthouses shall be all welded assembly with mitered corners. Reinforce with structural angles.

M. Provide manufacturer's roof curb of 18" minimum height for louvered penthouses.

N. Provide bird screen, 1/2" square mesh of 16 gauge, .051", expanded flattened aluminum. Screens shall be on the interior side of louver and shall be in a removable frame.

O. Provide formed metal sills of the same gauge and material as the louver, sized to lap under the louver sill and over the outside edge of the wall.

P. Louver finish: As selected by the Architect from submitted color samples. Submit color samples for review.

Q. Provide louvers with the AMCA Certified Ratings Seal for Air Performance and Water Penetration. Louver shall be tested and certified to the AMCA 500-L requirements.

R. Size louvers to provide no less than the required minimum free area indicated on the drawings.

S. Select intake louver velocity at or below the "Point of Zero Water Penetration".

T. Do not exceed 0.2" of water pressure drop across louvers.

U. Wind-driven rain resistant stationary louvers shall be as noted on the drawings and carry the Miami-Dade Notice of Acceptance (NOA).

V. Wind-driven rain louvers shall be Ruskin HZ850, EME42MD, or EME520DD or equivalent as noted on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install accessories in accordance with manufacturer's published recommendations as well as applicable sections of SMACNA manual and other standards set forth in Part 1.

C. Provide all screws, bolts, nuts, inserts, and material required for attaching sheet metal to duct, walls, floors, and ceilings.

D. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

E. Where diffusers or grilles and registers are not provided with volume dampers, install spin-in fitting with balancing damper in duct runout.

3.2 TESTING

A. Check work for satisfactory installation and performance.

B. Check duct connections at air inlets and outlets air leakage or condensation. Correct conditions found.

3.3 INSPECTION

A. Air inlets and outlets shall be clean and free from scratches and dents. Repair or replace damaged devices as required.

END OF SECTION

SECTION 23 41 00
PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Panel Filters

B. Pleated Filters

C. Housing and Frames

D. Filter Pressure Gauges

1.2 RELATED REQUIREMENTS

A. Section 23 05 00 - Common Work Results for HVAC.

B. Section 23 73 13 - Modular Central-Station Air-Handling Units.

1.3 REFERENCE STANDARDS

A. ASHRAE 52.2; 2012: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

B. ASHRAE 52.1; 1992: Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

C. NFPA 90A: Standard for the Installation of Air-Conditioning and Ventilating Systems.

D. UL 586: Standard for High-Efficiency, Particulate Air Filter Units.

E. UL 867: Electrostatic Air Cleaners

F. UL 900: Standard for Air Filter Units.

G. ISO 9001-2000: Certified manufacturing facility

1.4 SUBMITTALS

A. Submit manufacturer's product data for review in accordance with the requirements of Division 01.

B. Submit evidence of manufacturing facility certification with ISO 9001-2000.

1.5 QUALITY ASSURANCE

A. MERV Ratings: Minimum Efficiency Reporting Value of MERV when evaluated under the guidelines of ASHRAE Standard 52.2; 2012.

B. Average atmospheric dust spot and arrestance: Average dust spot efficiency of and a minimum arrestance based evaluation ASHRAE Standard 52.1; 1992.

C. Performance: Media to maintain or increase in efficiency over the life of the filter.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Airguard, American Air Filter (AAF), Camfil, or Flanders/Precisionaire.

2.2 PANEL FILTER MEDIA

A. Scheduled as AAF AmerSeal - MERV 8.

B. Construction

1. Media: Cotton and synthetic blend, self-sealing panel filter with internal wire support frame.

2. Filter shall be rated by Underwriters Laboratories as UL Class 900.

C. Performance

1. Efficiency: MERV 8; 25% average dust spot and minimum arrestance of 90% The media shall maintain or increase in efficiency over the life of the filter.

2. Initial resistance to airflow: Not to exceed 0.26" at airflow velocity of 500 feet/minute on 1" deep models.

2.3 PLEATED PANEL FILTERS

A. Scheduled as AAF AmAir 300X - MERV 7.

B. Construction

1. Media: Cotton and synthetic blend, lofted to a uniform depth of 0.18", and formed into a uniform radial pleats. There shall be at least 14 pleats per linear foot for 2" deep filters.

2. Support: Welded wire grid, spot-welded on one-inch centers, treated for corrosion resistance, bonded to the downstream side of the media to maintain the radial pleat and prevent media oscillation.

3. Frame: Minimum 28-point high wet-strength beverage board. Bond frame to media to prevent air bypass. Include integral diagonal support members on the air entering and air existing side to maintain uniform pleat spacing in varying airflow.

4. Filter shall be rated by Underwriters Laboratories as UL Class 900.

C. Performance

1. The filter shall have a Minimum Efficiency Reporting Value of MERV 7 and MERV-A of 7 when evaluated under the guidelines of ASHRAE Standard 52.2-2012 must include -B with appendix J. Minimum arrestance of 90% The media shall maintain or increase in efficiency over the life of the filter.

2. Initial resistance to airflow: Not to exceed 0.28" w.g. at airflow velocity of 500 feet/minute on 2" deep model.

2.4 PLEATED PANEL FILTERS

A. Scheduled as AAF Perfect Pleat HC M8 - MERV 8.

B. Construction

1. Media: Cotton and synthetic blend, lofted to a uniform depth of 0.18", and formed into a uniform radial pleats. There shall be at least 15 pleats per linear foot for 2" deep filters.

2. Support: Welded wire grid, spot-welded on one-inch centers, treated for corrosion resistance, bonded to the downstream side of the media to maintain the radial pleat and prevent media oscillation.

3. Frame: Minimum 28-point high wet-strength beverage board. Bond frame to media to prevent air bypass. Include integral diagonal support members on the air entering and air existing side to maintain uniform pleat spacing in varying airflow.

4. Filter shall be rated by Underwriters Laboratories as UL Class 900.

C. Performance

1. The filter shall have a Minimum Efficiency Reporting Value of MERV 8 and MERV-A of 8 when evaluated under the guidelines of ASHRAE Standard 52.2-2012 must include -B with appendix J. Minimum arrestance of 92% The media shall maintain or increase in efficiency over the life of the filter.

2. Initial resistance to airflow: Not to exceed 0.25" w.g. at airflow velocity of 500 feet/minute on 2" deep model.

2.5 FILTER PRESSURE GAUGES

A. Acceptable manufacturers: Dwyer Instruments, H.O. Trerice, or Weiss Instruments.

B. Magnehelic: Direct reading 3-1/2 inch (90 mm) diameter diaphragm actuated dial in metal case, vent valves, black figures on white background, front recalibration adjustment, +/-3% full-scale accuracy. Range shall start at zero and have a maximum of 0.25" to 1.0" w.c. above the scheduled final resistance. Mark scheduled clean and dirty resistance on face of dial. If two filter beds are installed in tandem, provide magnehelic across each filter bed.

C. Provide filter pressure gauges as specified in addition to BAS differential pressure sensor across each filter bank.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide filters in locations as shown on drawings. Provide quantity and sizes to comply with scheduled performance.

B. Upon completion of ductwork and fan system, clean systems as required in Section 23 05 00 - Common Work Results for HVAC and install specified filter media prior to placing system in operation.

C. All filters shall be installed prior to operating the HVAC system. Provide a complete change in filter media as required during construction and prior to the HVAC test and balance process. If equipment and/or ductwork is found to be contaminated at any point during construction, an independent NADCA certified contractor shall be retained to clean the ductwork and/or equipment at the contractors expense.

D. Install filters in accordance with manufacturer's published installation instructions. Provide manufacturer's recommended media change data to maintenance personnel.

E. Install filters in frames or apparatus casing so as to be leak free. Verify with light test from both sides.

F. Install and level filter gauges outside air stream for each bank of filters.

G. Protect cooling and/or heating coils with temporary media during construction.

H. Deliver one complete change of media to the maintenance personnel at Substantial Completion. Store spare media in a clean and dry place adjacent to equipment served or as coordinated with the Owner.

I. Provide insulation as required on filter housing to prevent condensation.

J. Insulate and make leak-proof filter access doors.

END OF SECTION

SECTION 23 62 13
PACKAGED AIR-COOLED REFRIGERANT COMPRESSOR AND CONDENSER UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Condensing unit package.

B. Charge of refrigerant and oil.

C. Controls and control connections.

D. Refrigerant piping connections.

E. Motor starters.

F. Electrical power connections.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete bases.

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

C. Section 23 23 00 - Refrigeration Piping System.

D. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

C. NEMA MG 1 - Motors and Generators 2018.

D. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures and requirements.

B. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams. Include equipment served by condensing units in submittal, or submit at same time, to ensure capacities are complementary.

C. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

D. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Include schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system.

E. Design Data: Indicate pipe and equipment sizing.

F. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

G. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

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

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. Extra Lubricating Oil: One complete change.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.7 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide a five year warranty to include coverage for refrigerant compressors.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Bryant, Lennox, Trane, or York International Corp / Johnson Controls.

B. Substitutions: Refer to Division 01.

2.2 PERFORMANCE REQUIREMENTS

2.3 CASING

A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.

B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.

C. Provide removable access doors or panels with quick fasteners and piano hinges.

2.4 CONDENSER COILS

A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig (2900 kPa), and vacuum dehydrate. Seal with holding charge of nitrogen.

2.5 FANS AND MOTORS

A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Equip with roller or ball bearings with grease fittings extended to outside of casing.

B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in current and thermal overload protection. Refer to Section 23 0513.

2.6 COMPRESSORS

A. Compressor: Semi-hermetic reciprocating type.

B. Mounting: Statically and dynamically balance rotating parts and mount on spring vibration isolators.

C. Lubrication System: Reversible, positive displacement oil pump with oil charging valve, oil level sight glass, and magnetic plug or strainer.

D. Motor: Constant speed 1800 rpm suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting. Furnish with starter.

E. Capacity Reduction Equipment: Suction valve unloaders, with lifting mechanism operated by electrically actuated solenoid valve, with unloaded compressor start; controlled from suction pressure.

F. Sump Oil Heater: Evaporates refrigerant returning to sump during shut down. Energize heater continuously when compressor is not operating.

2.7 REFRIGERANT CIRCUIT

A. Provide each unit with one refrigerant circuit, factory supplied and piped. Refer to Section 23 23 00.

B. For each refrigerant circuit, provide:

1. Filter dryer replaceable core type.

2. Liquid line sight glass and moisture indicator.

3. Thermal expansion valve for maximum operating pressure.

4. Insulated suction line.

5. Suction and liquid line service valves and gauge ports.

6. Liquid line solenoid valve.

7. Charging valve.

8. Discharge line check valve.

9. Compressor discharge service valve.

10. Condenser pressure relief valve.

C. For heat pump units, provide reversing valve, suction line accumulator, discharge muffler, flow control check valve, and solid-state defrost control utilizing thermistors.

2.8 CONTROLS

A. On unit, mount weatherproof steel control panel, NEMA 250, containing power and control wiring, molded case disconnect switch, factory wired with single point power connection.

B. For each compressor, provide across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for controls power. Provide manual reset current overload protection. For each condenser fan, provide across-the-line starter with starter relay.

C. Provide safety controls arranged so any one will shut down machine:

1. High discharge pressure switch (manual reset) for each compressor.

2. Low suction pressure switch (automatic reset) for each compressor.

3. Oil Pressure switch (manual reset).

D. Provide the following operating controls:

1. Thermostat located in room cycles compressors activates cylinder unloaders.

2. One minute off timer prevents compressor from short cycling.

3. Low ambient temperature controls.

4. Low ambient thermostat to lock out compressor at low ambient temperatures.

E. Provide controls to permit operation down to 0 degrees F (minus 18 degrees C) ambient temperature.

1. Thermostat to cycle fan motors in response to outdoor ambient temperature.

2. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.

3. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.

4. Electronic control consisting of mixing damper assembly, controlled to maintain constant refrigerant condensing pressure.

F. Gauges: Prepiped for suction and discharge refrigerant pressures and oil pressure for each compressor.

G. For multiple units, provide remote mounted sequence panel to allow operation with lead-lag switching and time delay timer.

H. Provide low voltage, adjustable thermostat to control heating stages in sequence with delay between stages, compressor stages, and supply fan to maintain temperature setting:

1. Include:

a. System selector switch (heat-off-cool).

b. Fan control switch (auto-on).

2. Provide single acting thermostat with minimum [_____] stage cooling.

3. Locate thermostat in room as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.

C. Provide for connection to electrical service. Refer to Section 26 05 83.

D. Install units on concrete base as indicated. Refer to Section 03 30 00.

E. Provide connection to refrigeration piping system and evaporators. Refer to Section 23 23 00. Comply with ASHRAE Std 15.

3.2 SYSTEM STARTUP

A. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.

B. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.

C. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

D. Provide cooling season start-up, and winter season shut-down for first year of operation.

END OF SECTION

SECTION 23 63 13
AIR COOLED REFRIGERANT CONDENSERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Refrigerant condenser package.

B. Charge of refrigerant and oil.

C. Controls and control connections.

D. Motor starters.

E. Electrical power connections.

1.2 RELATED REQUIREMENTS

A. Section 23 05 00 - Common Work Results for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 05 48 - Vibration and Seismic Controls for HVAC

D. Section 23 07 00 - HVAC INSULATION

E. Section 23 23 00 - Refrigeration Piping System

1.3 SUBMITTALS

A. Product Data: Provide rated capacities, weights, accessories, electrical requirements, and wiring diagrams.

B. Shop Drawings: Indicate components, assembly, dimensions, weights and loading, required clearances, and location and size of field connections. Include schematic layouts showing condenser, refrigeration compressors, cooling coils, refrigerant piping and accessories required for complete system.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Daikin Applied, Trane, or York.

B. Substitutions: Refer to Division 01.

2.2 MANUFACTURED UNITS

A. Provide packaged, factory assembled, pre-wired unit, suitable for outdoor use consisting of casing, condensing coil and fans, integral sub-cooling coil liquid accumulator.

B. Construction and Ratings: In accordance with AHRI 210/240 and UL 207. Testing shall be in accordance with ASHRAE Std 20.

C. Performance Ratings: Energy Efficient Rating (EER)/Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1, in combination with compressor units.

D. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.3 CASING

A. House components in welded steel frame with steel panels with weather resistant, baked enamel finish.

B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.

C. Provide removable access doors or panels with quick fasteners.

2.4 CONDENSER COILS

A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig (2900 kPa), and vacuum dehydrate. Seal with holding charge of nitrogen.

B. Coil Guard: Louvered with lint screens.

C. Configuration: Single refrigeration circuit with receiver.

2.5 FANS AND MOTORS

A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge, equipped with roller or ball bearings with grease fittings extended to outside of casing.

B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built-in current and thermal overload protection.

C. Motors as indicated, in compliance with Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

2.6 CONTROLS

A. Provide factory wired and mounted control panel, NEMA 250, containing fan motor starters, head pressure controls, compressor interlock, short cycling prevention timer, and control transformer.

B. Provide controls to permit operation specified ambient temperature.

C. Provide thermostat to cycle fan motors in response to outdoor ambient temperature.

D. Provide head pressure switch to cycle fan motors in response to refrigerant condensing pressure.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide for connection to electrical service.

C. Align condensers on level concrete foundations.

D. Provide connection to refrigeration piping system. Refer to Section 23 23 00 - Refrigeration Piping System. Comply with ASHRAE Std 15.

E. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

END OF SECTION

SECTION 23 74 13
PACKAGED DX ROOFTOP AIR HANDLING UNIT

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Packaged DX rooftop air units

B. Controls

C. Roof curbs

1.2 RELATED REQUIREMENTS

A. Section 23 05 48 - Vibration Isolation

B. Section 23 05 00 – Common Work Results for HVAC

C. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC

D. Section 23 31 13 – Sheetmetal Ductwork

1.3 SUBMITTALS

A. Submit product data for review in accordance with the provisions of Division 01.

B. Product data shall include, but not be limited to:

1. Unit dimensions and weights
2. Fan curves
3. Capacities
4. Unit construction
5. Roof curbs
6. Noise criteria and sound performance
7. Manufacturer’s installation instructions
8. Electrical wiring diagrams and connection information
9. Warranty

1.4 QUALITY ASSURANCE

A. Unit shall have American Gas Association (AGA) design certification.

B. Entire unit shall be UL and/or ETL Listed and certified and shall be so labeled.

C. Coils shall be AHRI Certified per Standard 410.

1.5 DELIVERY, STORAGE AND HANDLING

A. Unit shall be shipped with doors bolted shut and outside air hood closed to prevent damage during transport and thereafter while in storage prior to installation.

B. Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading unit at its final location.

C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

1.6 WARRANTY

A. Unit and systems shall have a full parts and labor warranty as identified in Division 01 from the date of substantial completion.

B. Other components such as compressors shall have extended warranties as noted in the following paragraphs of this section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. AAON

B. Valent

C. Daikin Applied

D. Lennox

2.2 UNIT CONSTRUCTION

A. Heavy gauge double wall steel panels, factory painted exterior, galvanized interior, with integral thermal break. Unit roof cap shall be cross-broken to shed water.

B. Steel base rails, with unit lifting lugs.

C. Insulation: 2” minimum thickness, (R-12) polyurethane foam between double wall steel panels on unit top, sides and bottom.

D. Double sloped stainless steel, insulated drain pan.

E. Hinged access panels for compressor, controls, heating coils, blower and filter access, sealed with quarter turn latching handles with water-tight gasket seal.

F. Supply and return duct connections shall be bottom or side as shown on the drawings.

G. Where manual or automatic volume and control dampers are provided in the outside air inlet, the damper construction shall be constructed of 6010 aluminum or 304 stainless steel.

H. Provide 18” minimum height (or as noted) roof curb to fit the unit perimeter dimensions.

2.3 UNIT COMPONENTS AND FEATURES

A. Air cooled direct expansion cooling system, factory charged and ready for operation. Equip hermetic type compressors with positive pressure forced lubrication system, crankcase heater, and high/low pressure cut-outs.

B. Dual spring isolated hermetic digital scroll or inverter scroll compressors. Motor compressors to be warranted against failure for five years after date of substantial completion.

C. Cooling coils and condenser coils shall have aluminum fins mechanically bonded to copper tubes, leak tested to 350 psig minimum.

D. Unit shall provide cooling with 100% outside air including a relief/return air system sized to exhaust 100% of the supply air for the economizer cycle. Provide Air Blender where required by the drawings.

E. Unit shall have an Air Flow Measuring Station (AFMS) in outside air inlet.

F. Unit shall have a non-fused disconnect switch, short-circuit fuse protection, internal electrical components, required motor starters, VFDs, contactors, and overcurrent protection.

G. Unit shall be factory wired, charged and tested, UL listed and AHRI certified.

H. Unit features, accessories and options shall be as noted and as scheduled on drawings.

I. Provide modulating hot gas reheat as scheduled.

J. AMCA Low-Leakage modulating dampers.

2.4 FAN SECTION(S)

A. Provide DWDI fan with galvanized or phosphatized painted steel scroll housing.

B. Supply, return and exhaust fans shall be AMCA Certified and labeled, direct drive or belt driven, housed or plenum fans, VFD controlled.

C. Provide air foil, forward curved or backward inclined fan wheel as scheduled on drawings. Dynamically balance fan before and after installation in the cabinet section.

D. Provide fan shaft keyed, set screwed or clamped to the wheel per the manufacturer's standard design to meet the specified performance. Maximum fan rpm to be well below the first critical speed.

E. Provide units with resiliently mounted internal fan motor(s) on 1” deflection spring isolators. Locate motor(s) on factory slide rail base complete with adjustment nuts. Provide access to fans and internally mounted motor(s) and all bearings.

F. Provide fan bearings of the ball, roller, or pillow block type, self-aligning and grease lubricated. Provide extended lubrication lines from fan bearing to unit casing. Connect lubrication lines to a Zerk fitting mounted on the casing. Select bearings for an average life of 200,000 hours at design operating conditions.

G. Condenser fans shall be propeller type, direct driven with ECM motors.

2.5 GAS HEATING SECTION

A. Induced draft, natural gas fired with direct spark ignition

B. Electronic flame sensors

C. High heat limit sensors

D. Stainless steel tubular heat exchanger

E. Redundant gas valves with manual shutoff

F. Multi-stage or modulating heating

G. Aluminized steel gas burners

H. Fan and limit controls and safety switches

2.6 FILTER SECTION

A. Provide pre-filter and final filter section with filter type, MERV rating and efficiency as scheduled on drawings.

B. Provide a flush mount magnehelic filter gauge across each filter bank.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units in locations shown on drawings and in accordance with manufacturer's instructions.

B. Controls to be furnished by the unit manufacturer and factory installed, except for thermostat and remote monitoring panel furnished by the unit manufacturer and installed under the electrical division.

C. Controls for unit shall be as shown on drawings.

D. Fill void between bottom of unit and structural slab or deck as detailed on the drawings.

E. Install unit on roof curb in accordance with manufacturer’s instructions. Provide isolation curb and seismic tie-downs, and hurricane windstorm straps as required.

3.2 TEST AND ACCEPTANCE

A. Start-up and checkout fan for proper motor phasing, alignment, and vibration free operation. Correct improperly aligned fans. Change unmatched belts.

B. Test fans in accordance with Section 23 05 00 and balance in accordance with Section 23 05 93.

C. Demonstrate system operation to Owner's maintenance personnel and instruct them in operational requirements.

D. Verify that, where applicable, fans are interlocked with return (and exhaust) fans as required by control drawings.

END OF SECTION

SECTION 23 81 26
SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air cooled condensing units.

B. Indoor ductless fan & coil units.

C. Controls.

1.2 RELATED REQUIREMENTS

A. Section 23 05 00 - Common Work Results for HVAC

B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

C. Section 23 31 13 - Sheetmetal Ductwork

1.3 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.

B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.

C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.

D. ASHRAE Std 23.1 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010.

E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.

F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems; National Fire Protection Association; 2012.

G. UL 207 - Refrigerant-Containing Components and Accessories, Nonelectrical; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

B. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

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

1.5 QUALITY ASSURANCE

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

1.6 WARRANTY

A. Provide one year parts and labor warranty for all unit components.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Daikin, Lennox, Trane, or York.

B. Substitutions: Refer to Division 01.

2.2 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.

1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator; auxiliary electric heat.

2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

B. Performance Requirements: See Drawings for additional requirements.

1. Efficiency:

a. Seasonal Energy Efficiency Ratio: 10.0, minimum.

b. Comply with ASHRAE Std 90.1.

2.3 INDOOR UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

1. Location: High-wall.

2. Cabinet: Galvanized steel.

a. Finish: White.

3. Fan: Line-flow fan direct driven by a single motor.

4. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.

B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.

1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.

C. Remote Actuators:

2.4 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.

1. Comply with AHRI 210.

2. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

3. Refrigerant: R-410A.

4. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.

5. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.

6. Sound Rating: 69 dBA, when measured in accordance with AHRI 270.

B. Compressor: AHRI 520; hermetic, two speed 1800 and 3600 rpm, resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.

C. Air Cooled Condenser: ARI 520; Aluminum fin and copper tube coil, with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

1. Condenser Fans: Direct-drive propeller type.

2. Condenser Fan Motor: Enclosed, 1-phase type, permanently lubricated.

D. Coil: Air-cooled, aluminum fins bonded to copper tubes.

E. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).

1. Provide thermostatic expansion valves.

2. Provide heat pump reversing valves.

F. Operating Controls:

1. Control by room thermostat to maintain room temperature setting.

2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig (1965 kPa) and off when pressure drops below 140 psig (965 kPa) for operation to 0 degrees F (-18 degrees C).

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available and in correct location.

C. Verify that proper fuel supply is available for connection.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.

B. Install in accordance with NFPA 90A and NFPA 90B.

C. Provide reinforced housekeeping pad for units mounted on grade. Pad shall be made level and 6" wider than unit on all sides unless noted otherwise.

D. Secure refrigerant lines to prevent vibration.

E. Locate outdoor unit to comply with manufacturer's recommended minimum clearances.

F. Startup and test units for proper operation, both heating and cooling, in accordance with manufacturer's recommendations and HVAC test and balance requirements.

END OF SECTION

SECTION 23 82 39
TERMINAL HEATING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electric Unit Heaters

1.2 RELATED REQUIREMENTS

A. Division 26: Electrical

B. Section 23 07 00 - HVAC Insulation

C. Section 23 09 13 - Instrumentation and Control Devices

1.3 SUBMITTALS

A. Submit product data for review in accordance with the requirements of Division 01. Provide equipment performance data indicating compliance with and meeting the capacities scheduled on the drawings.

B. Submit schedules of equipment and enclosures typically indicating the length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of scheduled heat required to actual heat output provided.

C. Indicate mechanical and electrical service locations and requirements.

1.4 QUALITY ASSURANCE

A. Provide U.L. listing and labels on all units.

B. Provide AGA approval on gas fired units.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with a minimum of 5 years documented experience.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. As noted for each product type below.

2.2 UNIT HEATERS

A. Acceptable Manufacturers: Airtherm, American Air, Dunham Bush, Modine, Reznor, Sterling, or Trane.

B. Electric Unit Heaters: Size, type and capacity as indicated on drawings.

1. Casing, heater element, circuit subdivision and fusing where required
2. Cabinet enclosure with directional discharge louvers
3. Wall mounted line voltage thermostat
4. Five year heater element warranty
5. Fan motor, totally enclosed, with thermal overload protection and permanently lubricated
6. High temperature cut out with manual reset

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions in locations scheduled on drawings.

B. Unit heaters shall be placed no closer than 7'-0" cylinder radius extending 7'-0" above and 2'-0" below the unit heater to any sprinkler head. High-temperature rating heads shall be used where required and as defined in NFPA 13. Coordinate placement with room layout, sprinkler head layout and fire protection contractor.

C. Coordinate electrical connections and maintain accessibility.

D. Provide access covers as required for access to piping, valves and controls.

E. Align cabinet joints with window mullions.

F. Protect unit and provide finished units with protective covers during the balance of construction.

G. Install end caps where units butt against walls. Run cover continuously wall-to-wall unless otherwise indicated.

3.2 START-UP, TEST, DEMONSTRATION

A. Start-up and test equipment for proper operation.

B. Operate and test all safety devices and controls.

C. Demonstrate operation of equipment to maintenance personnel.

D. Remove and replace malfunctioning units and retest.

3.3 CLEANING

A. After construction and painting is completed, clean exposed surfaces of units.

B. Vacuum clean coils and inside of units.

C. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

END OF SECTION

SECTION 23 84 13
HUMIDIFIERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electric Resistive Element Steam Humidifiers

B. Condensate Drain Cooler

1.2 RELATED REQUIREMENTS

A. Section 23 07 00 - HVAC INSULATION

B. Section 23 21 13 - HVAC Piping

C. Section 23 22 16 - Steam and Condensate Specialties

D. Section 23 31 13 - Sheetmetal Ductwork

E. Division 26: Electrical

1.3 SUBMITTALS

A. Submit product data and information for review in accordance with the provisions of Division 01.

B. Product Data: Provide catalog sheets indicating general assembly, dimensions, weights, materials, and certified performance ratings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Armstrong, DriSteem, Herrmidifier Company, Nortec, or Pure Humidifier.

1. Humidifiers and drain cooler shall be provided from the same manufacturer.

2.2 ELECTRIC RESISTIVE ELEMENT STEAM HUMIDIFIER

A. Furnish a self-contained electric element steam humidifier to meet scheduled capacity. The humidifier shall be capable of operating on normal or demineralized water without modification.

B. Unit(s) shall have a serviceable stainless steel steam canister with corrosion resistant heating elements, water level sensor, and a high-temperature limit switch.

1. The steam tank shall be constructed of stainless steel and include a drain strainer. The tank shall also have an integral surface skimming port to remove floating debris and foam during fill cycles when non-treated water is used. This feature shall have user

adjustable interval & duration. The cover shall include a silicone gasket and shall be removable by loosening threaded fasteners. The steam tank shall have a manual reset high temperature limit switch and act to de-energize the power contactor in the event of an over-temperature condition.

2. The electric heating elements shall be constructed with corrosion resistant, alloy sheaths and have screw down type connections.

3. The steam generator tank shall include water level controls in the form of two float switches and be located in a portion of the tank segregated from the main steam generating portion of the tank. Water level electrodes, float switches, and/or valves located in the main portion of the tank are subject to excessive mineral build-up are not acceptable.

4. Water make-up system shall include inlet strainer, solenoid valve with flow regulator, and fill tee with built-in air gap to prevent back siphoning.

5. Drain system shall consist of a solenoid valve, with shielded core dry operator.

C. Humidifier cabinet shall be minimum 18 gauge steel and power-coat painted to protect against corrosion. The electrical and steam generating compartments shall be separate, but contained within the same cabinet to minimize field wiring. The access doors shall be lockable with a key.

1. Power to the resistive heating elements shall be controlled through the actuation of contactors and solid state relays.

2. Terminal connection points for all line and low voltage (control) connections. A system on/off switch shall be externally available. A door interlock switch shall prevent operation when the access door is open.

3. The unit(s) will utilize one of the following humidity control systems (shown with corresponding input method):

   a. On/Off (Humidistat)

   b. Proportional (Transmitter or signal-ohms, VDC, mADC)

   c. Proportional + Integral (Sensor or signal - VDC , mADC)

4. Unit controls shall also include:

   a. A proportional high limit device (or signal) to enable modulating control systems to adapt the capacity setpoint to variable airflow.

   b. Duct mounted high level limit humidistat.

   c. Air proving switch

5. A Native BACnet microprocessor control, monitor and diagnostic system. The microprocessor control shall:

   a. Sense humidifier demand and adjust water level and output capacity.

   b. Include a backlit LCD display -- (2) lines, 16 alphanumeric characters per line -- to monitor system operation/performance.

      1) Note: Only parameters pertinent to the specific humidity control system shall be displayed.

      2) Provide programmable set points with built-in default values for simplified startup. Only set-points pertinent to the control mode are accessible.

         (a) Note: Certain set-points shall be password secured to prevent tampering; such as PID loop settings.

      3) Provide adjustable drain tempering capability.

      4) Provide "fault" sensing, record fault history, and display the type of fault. Certain faults shall result in system shutdown. Other faults reflect a potential maintenance problem and allow the unit to continue operation.

      5) Network ability to common FMS systems such as BACnet, Modbus, N2, or Lonworks.

D. Humidistat: Wall mounted.

E. Provide multiple tube dispersion assembly as follows:

   1. Assembly shall be sized as required to comply with maximum absorption distance scheduled.

   2. Provide complete assembly with the following:

      a. Fabricated stainless steel horizontal header/separator at bottom of assembly, sloped for sufficient drainage.

      b. Vertical stainless steel dispersion tubes with top support connections.

      c. The distribution manifold shall provide uniform distribution over its entire length and be jacketed by steam to assure that vapor discharged is free of water droplets.

F. Room Distribution Unit (RDU) with adjustable speed control

   1. The supply air blower shall operate approx. 15 minutes after humidifier unit shutdown. Steam input shall be thru the bottom or back of the unit. The RDU shall be unit mounted. Supply voltage and control input shall be provided by the humidifier.

2.3 CONDENSATE DRAIN COOLER

A. Provide external stainless steel condensate drain cooler for humidifiers that do not contain internal drain coolers to temper the steam condensate to less than 130 deg. F using domestic cold water, hot water, or tempered water.

B. Drain cooler shall have the following options:

1. Wall mount bracket.
2. 1" air gap fitting for discharge piping
3. Integral temperature actuated cold water valve.
4. Vacuum breaker to prevent backflow into potable water system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Insulate humidifier, dispersion tube(s), and condensate piping in accordance with manufacturer's written recommendations and as specified in Section 23 07 00 - HVAC INSULATION. Provide working NEC required working clearance.

B. Install humidifier dispersion tube(s) in ductwork with recommended distance from elbows, transitions, and offsets to insure absorption of moisture into air steam.

C. Install steam and condensate piping to insure dry steam is supplied to humidifier. Install steam supply end of main traps as required for proper operation.

D. Provide stainless steel pan in duct 3 ft. before and after humidifier distribution tube/header. Provide access door in side of duct.

E. Install humidifiers and limit humidistat in strict accordance with manufacturer's written instructions.

F. Install drain cooler in strict accordance with manufacturer's written instructions. Size make-up water piping based on anticipated temperature of make-up water. Support unit body separately from connected piping.

3.2 START-UP AND TESTING

A. Start-up and test humidifiers, humidistats, and condensate cooler for satisfactory operation as part of steam/condensate system and control system. Check to ensure all valves are open and that humidifier responds to humidistat over selected ranges. Check high limit humidistat for proper operation. Check condensate piping for proper slope back to generating unit or condensate cooler. Set drain/fill and skimming controls as appropriate and as recommended by manufacturer for the specific application and water quality.

B. Demonstrate to and instruct facility engineering personnel in system operation.

C. Provide manufacturer's operation and maintenance manuals and parts list as required by Section 23 05 00 - Common Work Results for HVAC.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic materials and methods, along with Division 01, General Requirements, that are applicable to Division 26 sections.

B. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 specification Sections apply to all Division 26 sections.

1.2 RELATED REQUIREMENTS

A. Perform Work specified in Division 26 in accordance with reference standards listed below of the latest applicable edition adopted by the authority having jurisdiction. Where these Specifications are more stringent, they shall take precedence. In case of conflict, obtain a decision from the Architect.

1.3 REFERENCE STANDARDS

A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design 2010.

B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.

C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.

D. State of Indiana Electrical Code 2009 Edition

1.4 RELATED WORK SPECIFIED UNDER OTHER DIVISIONS

A. Foundations and pads required for equipment furnished under this Division

B. Field painting, except such painting as is required to maintain shop coat painting and factory finish painting

C. Flashing of conduits into roofing and outside walls

D. Heating, ventilating, and air conditioning equipment

E. Plumbing equipment

F. Fireproofing

G. Automatic Doors

H. Cutting and patching for electrical Work, except for errors and omissions under this Division.

1.5 RELATED WORK - OWNER FURNISHED EQUIPMENT AND SYSTEMS

A. Kitchen equipment

B. Television system equipment

C. Music/paging system equipment

1.6 SUBMITTALS

A. Comply with provisions of Division 01.

B. Submit product data, equipment details, capacities, and shop drawings as specified in sections of this Division.

C. Submit fire alarm point-to-point drawings with product data submission.

D. Organize submittal material to comply with the following submittal and deviation schedules for ready recognition and uniformity. Required items re listed separately for clarity, but for each specification section , a single, comprehensive package shall be submitted for review. Individual submittals for each line item will not be accepted.

1. SD 01 - Data (Calculations and support criteria)

2. SD 02 - Manufacturer's Catalog Data

3. SD 03 - Manufacturer's UL or ETL listing and or rating

4. SD 04 - Drawings (Layout and Assembly Information)

5. SD 05 - Design Data

6. SD 06 - Instructions (Manufacturer's and Engineer of Record)

7. SD 07 - Schedules (Testing and Demonstration)

8. SD 08 - Statements (Installer's and Testing Personnel and Procedures)

9. SD 09 - Reports (Routine Testing and Inspections)

10. SD 10 - Test Reports (NEMA, ANSI, ASTM required)

11. SD 11 - Factory Test Reports (Owner witness and/or collaborative)

12. SD 12 - Field Test Reports (Operating Tests and Demonstration)

13. SD 13 - Certificates (Master UL (Lightning), Elevators, etc.)

14. SD 14 - Samples

15. SD 15 - TBA

16. SD 16 - TBA

17. SD 17 - TBA

18. SD 18 - Records (Tests Results, etc.)

19. SD 19 - TBA

20. SD 20 - Training (To be provided)

E. Submit dimensioned equipment room layouts.

1. Show location of all electrical equipment in rooms including but not limited to:

a. Electrical rooms and closets

2. Draw room layouts to 1/4" scale, with equipment locations shown therein. Clearances shall be in accordance with NEC and local codes. Indicate on drawing the mechanical equipment and mechanical and sprinkler pipe routing.

3. Electrical equipment submittals will be rejected without dimensioned equipment room or equipment location layouts and the completed power systems study.

F. Prepare shop drawings completely independent of the Engineer of Record's CADD files. Should the Contractor or Vendor wish to use the Engineer of Record's CADD files as the basis for developing their shop drawings, a release form, obtainable from the Engineer or Architect, must be signed and a nominal charge of $50.00 per sheet must be made payable to the engineering firm to cover the cost of preparing the drawings for use by others.

1.7 QUALITY ASSURANCE

A. Comply with applicable local, state, and federal codes.

B. Warrant electrical Work against faulty material or Workmanship in accordance with Division 01. If the Project is occupied or the systems placed in operation in several phases at the request of the Owner, then the warranty of each system or piece of equipment used shall begin on the date each system or piece of equipment was placed in satisfactory operation and accepted as such, in writing, by the Owner. The use of building equipment for temporary service and testing does not constitute the beginning of the warranty.

C. Equipment and material provided under this Division shall be periodically inspected and serviced by competent mechanics. This function becomes the responsibility of the Owner when the system is accepted by the Owner. The one year material and Workmanship warranty is not intended to supplant normal inspection or service and shall not be construed to mean the Contractor shall provide free service for normal maintenance items such as periodic lubrication and adjustment due to normal use, nor to correct without charge, breakage, maladjustment, and other trouble caused by improper maintenance.

D. Turn over electrical equipment provided under this Division to the Owner in lubricated condition. Include instructions on further lubrication in the operating manual.

E. Upon completion of contract and progressively as work proceeds, clean-up and remove dirt, debris and scrap materials. Maintain premises neat and clean. Protect and preserve access to energized equipment at all times. Clean items with factory finishes. Touch-up minor damage to surfaces; refinish entire piece of equipment when sustained major damage. Use only factory supplied paints of matching color and formula. Schedule an off-hour shutdown of all electrical equipment during the 2-week period preceding substantial completion. During this shut down, clean all buses and insulators inside all switchgear, switchboards, bus ducts, collector buses and panelboards located inside or adjacent to the project limits.

1.8 OPERATING AND MAINTENANCE MANUALS

A. Provide manuals in accordance with Division 01.

B. In addition to required submittals, include copies of all test reports required in Part 3, "Execution" of Section 26 05 00 - Common Work Results For Electrical.

C. Provide completed warranty certificates for systems and equipment.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Insofar as possible, deliver items in manufacturer's original unopened packaging. Where this is not practical, cover items with protective materials to keep them from being damaged. Use care in loading, transporting, unloading, and storage to keep items from being damaged.

B. Store items in a clean dry place and protect from damage. Evidence of damage from water or other contaminants will be cause for rejection.

1.10 PRODUCT PROCUREMENT AND SUBSTITUTION

A. Comply with the provisions of Division 01.

1.11 FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

1.12 RECORD DRAWINGS

A. Comply with provisions of Division 01.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Equipment and materials furnished shall be listed by UL or other nationally accredited testing laboratory where available. When listing is not available for a piece of equipment, it shall be submitted in accordance with Drawings and Specifications and shall be approved by the authorities having jurisdiction.

B. Specifications and Drawings indicate name, type and/or catalog number of materials and equipment to establish standards of quality. Submittals shall be based on the standards specified. The standards should not be construed as limiting competition.

C. If materials and equipment other than specified herein are intended to be submitted, a letter providing a list of all the suggested alternates by section number, brand and series or model shall be submitted to the Architect for review and approval. Submit in accordance with Division 01 and a minimum of 14 days prior to submission of bids.

2.2 FUSES

A. Provide fuses as scheduled on Drawings for switchboards, power panelboards and disconnecting switches.

B. Acceptable manufacturers: Bussmann; Gould Shawmut; Littelfuse, Inc

C. Provide fuses of one manufacturer only. Place the same type fuse in each pole of a switch.

D. Use these types:

1. Class L-601A-6000A; Switchboards, all load types

2. Class J-Time Delay-1A-600A; Switchboards, motor loads

3. Class J-Fast Acting-1A-600A; Switchboards, other loads

4. Class RK5-Time Delay-1/10A-600A; Power panels and fusible switches, motor loads

5. Class RK1-Fast Acting-1A-600A; Power panels and fusible switches, other loads

2.3 WALL AND CEILING ACCESS PANELS

A. Style and type as required for material in which installed.

1. Size: 16" X 16" minimum, as indicated, or as required to allow inspection, service and removal of items served

2. 14 gauge minimum sheet metal for doors, 16 gauge frames of cadmium-plated or galvanized construction. Doors shall have expanded plaster rings where located in plaster walls or flanged finish where located in drywall or block construction

3. Panels shall have spring hinges with screwdriver locks in non-public areas. Key lock, keyed alike, for panels in public areas

4. Prime painted or rust inhibitive paint finish

5. UL labeled when in fire-rated construction, 1 1/2 hour rating

6. Provide in walls, floors, and ceilings to permit access to all equipment and junction boxes.

7. Furnish and locate access panels under this Division. Coordinate with trades who are responsible for building system in which panels are to be installed.

8. Acceptable manufactures: Milcor, Nystrom, Karp, J.L. Industries, or Williams Brothers. Use panels equal to Milcor Style M for masonry and drywall construction; equal to Milcor Style K for plastered masonry walls and ceilings. Stainless steel panels shall be used in ceramic tile or glazed structural tile

PART 3 - EXECUTION

3.1 COORDINATION

A. Install equipment in accordance with manufacturer's recommendations. Where conflicts occur between Contract Documents and these recommendations, request a ruling before proceeding with such Work.

B. Visit site and observe conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform work required by these documents.

C. Examine Specifications and Drawings to be familiar with items which require electrical connections and coordination. Electrical Drawings are diagrammatic and shall not be scaled for exact sizes.

3.2 TEMPORARY LIGHTS AND POWER

A. Comply with provisions of Division 01.

B. Provide a temporary electrical lighting and power distribution system of adequate size to properly serve the following requirements, including adequate feeder sizes to prevent excessive voltage drop. Temporary Work shall be installed in a neat and safe manner in accordance with the National Electrical Code, Article 305, NFPA 241, and as required by OSHA or applicable local safety codes.

C. Provide one pigtail socket with 150 watt lamp, CFL medium base, for every 1,000 square feet of floor area, evenly distributed throughout the building and with minimum of one pigtail socket per room.

D. Provide suitable guards for temporary lights to prevent accidental contact with lamps.

E. Provide a minimum of one GFCI-protected duplex power outlet for every 1,500 square feet of floor area, evenly distributed throughout the building. Power outlets shall be GFCI-protected duplex 20 amp, 120 volt.

F. Provide feeders, disconnects, connections, etc., required for construction equipment, eg: cranes, pumps, etc.

G. Prior to installation, determine if any lighting or power outlets over the minimum quantity noted above are required and if so, provide them.

H. Provide service and panelboards required for above lighting and power outlets.

I. Requirements for payment of utility bills during construction are specified in Division 01.

J. Provide single phase and three phase service as required by Project.

K. Remove temporary wiring upon completion of use.

3.3 DEMOLITION

A. Visit the site to observe existing conditions before submitting a bid.

B. Work in existing buildings shall be scheduled well in advance with the Owner. Work shall be performed at such times and under such conditions as suit the convenience of the Owner . Plan the Work to minimize disruption of normal operations. Notify Owner before any circuit is de-energized in occupied areas.

C. Reconnect circuits to other panelboards when required to complete the renovation shown.

D. Remove abandoned wire and conduit back to source. Splice and terminate in junction boxes as appropriate. Where entire circuit is to be removed, remove conduit and wire back to existing panelboard. Where such work would not be possible without disturbing areas not being renovated, consult with the Architect prior to performing the work.

E. Where a circuit is interrupted by removal of a device or fixture from that circuit, install wire and conduit as required to restore service to the remaining devices and fixtures on that circuit. Ensure proper grounding is maintained.

F. Lighting fixtures, wiring devices, panelboards, equipment, conduits and conductors removed shall be transported to the Owner’s designated location and offered to the OWNER. If he chooses to retain these items or a part of these items, turn those chosen over to him. Items rejected by the OWNER shall be removed completely from the project site and disposed of legally by the CONTRACTOR.

3.4 CUTTING AND PATCHING

A. Comply with provisions of Division 01

B. Repair or replace routine damage caused by cutting in performance of Work under this Division.

C. Correct unnecessary damage caused due to installation of electrical Work, brought about through carelessness or lack of coordination.

D. Holes cut through floor slabs shall be core drilled with drill designed for this purpose. All openings, sleeves, and holes in slabs between floors shall be properly sealed, fire proofed and water proofed.

E. Holes cut through walls shall be drilled or cut with tools designed for the purpose. All openings, sleeves and holes in walls that extend to underside of floor above shall be properly sealed and fire proofed.

F. Repairs shall be performed with materials which match existing materials and be installed in accordance with appropriate sections of these Specifications.

G. Contractor shall not be permitted to cut or modify any structural members without the written permission of the Architect.

3.5 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

A. Comply with provisions of Division 31.

B. Provide trenching, excavation, and backfilling necessary for performance of Work under this Division.

C. Provide sheathing, shoring, dewatering, and cleaning necessary to keep trenches and their grades in proper condition for Work to be performed.

D. Trenching and excavation shall be unclassified. No extra will be paid in event that rock is encountered.

3.6 FOUNDATIONS AND PADS

A. Provide concrete foundations and pads for equipment per the requirements Division 03. Locate and size foundations, pads, and anchor bolts as required for equipment in this Division.

B. Provide concrete foundations and pads as required for electrical utility company's equipment such as transformers, CT cabinets, metering cabinets, switches, fused disconnects, and circuit breakers. All work shall be in compliance with the utility company's specifications.

3.7 CONTROL SYSTEMS AND INTERLOCK WIRING

A. Control systems, components and control and interlock wiring for mechanical equipment will be furnished under Divisions 21, 22 and 23. Control devices including, but not limited to, thermostats, fan speed and level control switches, relays and electro-pneumatic switches shall be furnished under Divisions 22 and 23.

B. Provide magnetic starters per Section 26 29 13 - Enclosed Controllers.

C. Provide manual motor starters per Section 26 29 13 - Enclosed Controllers.

D. Provide variable frequency motor controllers per Section 26 29 23.

E. Provide power wiring to starters, variable frequency motor controllers, and contactors under Division 26. Power wiring to magnetic starters and variable frequency motor controllers shall consist of wiring to the line side terminals of the magnetic starter or contactor or variable frequency motor controller and wiring away from the load side terminals to the equipment, except where such wiring is installed pre-wired by the equipment vendor. Where external filters are required for harmonic control, wiring to/from this equipment shall be included.

1. Power wiring to 120V, 1-phase, 60 Hz and 277V, 1-phase, 60 Hz volt fans, unit heaters, fan-coil units, VAV boxes, pumps and other equipment shall include all portions of the branch circuit, except for wiring inside an automatic temperature control panel (ATC) or Direct Digital Control Panel (DDC), Building Automation System panels, equipment control panels, variable frequency motor controllers, or magnetic starters. Such internal wiring shall be furnished under Divisions 21, 22 and 23.

F. Under Division 28:

1. Furnish duct mounted smoke detectors.

2. Provide wiring among detectors, fire alarm system, magnetic starters, variable frequency motor controllers, and relays, ATC panels and DDC panels

G. See Building Automation System sections of Division 23.

3.8 UTILITY COMPANY COORDINATION

A. Coordinate with the serving utility company as to all types of work required to be done by the contractor for utility equipment.

B. Confirm exact location of point of common coupling, duct banks, pads, etc.

C. Obtain copies of all pertinent utility company specifications relating to duct banks, concrete pads, raceways, and cable that are contractor installed for the utility company use. Maintain copies at project site.

D. Install at components in compliance with utility company specifications and project specifications.

3.9 TESTING ELECTRICAL SYSTEMS

A. On completion of work, installation shall be completely operational and entirely free from grounds, short circuits, and open circuits. Perform operational tests as required to demonstrate substantial completion of the Work. Balance circuits so that feeders to panels are not more than 10% out of balance between phases with all available load energized and

operating. Furnish all labor, materials and instruments for above tests. All ampere readings shall be made with a true RMS reading meter.

B. Perform megger tests of all service entrance circuits, feeder and branch circuits size #1/0 AWG and larger. Provide a report of all such megger test results.

C. Furnish the Architect a copy of test reports and required certification including but not limited to the following:

1. Service ground resistance test
2. Switchboard and panelboard load test - include ampere readings of all panels and major circuit breakers
3. Ground Fault Test
4. Fire Alarm System Certification
5. Power System Analysis Report

D. Prior to final observation and acceptance test, install all electrical systems and equipment complete and in satisfactory operating condition.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single conductor building wire.

B. Armored cable.

C. Metal-clad cable.

D. Wiring connectors.

E. Electrical tape.

F. Heat shrink tubing.

G. Oxide inhibiting compound.

H. Wire pulling lubricant.

I. Cable ties.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.

B. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire 2013 (Reapproved 2018).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft 2011 (Reapproved 2017).

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes 2010, with Editorial Revision (2020).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation 2004 (Reapproved 2020).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape 2017.

F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes 2020.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

H. NECA 120 - Standard For Installing Armored Cable (Type AC) And Metal-Clad Cable (Type MC) 2018.

I. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy 2021.

J. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.

K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 4 - Armored Cable Current Edition, Including All Revisions.

M. UL 44 - Thermoset-Insulated Wires and Cables Current Edition, Including All Revisions.

N. UL 83 - Thermoplastic-Insulated Wires and Cables Current Edition, Including All Revisions.

O. UL 486A-486B - Wire Connectors Current Edition, Including All Revisions.

P. UL 486C - Splicing Wire Connectors Current Edition, Including All Revisions.

Q. UL 486D - Sealed Wire Connector Systems Current Edition, Including All Revisions.

R. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape Current Edition, Including All Revisions.

S. UL 1569 - Metal-Clad Cables Current Edition, Including All Revisions.

T. UL 2196 - Fire Test for Circuit Integrity of Fire Resistive Power, Instrumentation, Control and Data Cables

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Coordinate the installation of direct burial cable with other trades to avoid conflicts with piping or other potential conflicts.

3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.

4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

D. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed system layout with components identified; indicate branch circuit connections.

E. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.

F. Field Quality Control Test Reports.

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

H. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F (-10 degrees C), unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Armored cable is permitted only as follows:

1. Where not otherwise restricted, may be used:

a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.

1) Maximum Length: 6 feet (1.8 m).

2) Do not daisey chain light fixtures

D. Metal-clad cable is permitted only as follows:

1. Where not otherwise restricted, may be used:

a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.

1) Maximum Length: 6 feet (1.8 m).

2) Do not daisy chain light fixtures

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Provide new conductors and cables manufactured not more than one year prior to installation.

D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

E. Comply with NEMA WC 70.

F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

H. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.

I. Conductor Material:

1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.

2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.

3. Tinned Copper Conductors: Comply with ASTM B33.

J. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.

a. Exceptions:

1) 20 A, 120 V circuits longer than 75 feet (23 m): 10 AWG, for voltage drop.

2) 20 A, 120 V circuits longer than 150 feet (46 m): 8 AWG, for voltage drop.

3) 20 A, 277 V circuits longer than 150 feet (46 m): 10 AWG, for voltage drop.

2. Control Circuits: 14 AWG.

K. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

L. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.

2. Color Coding Method: Integrally colored insulation.

3. Color Code:

a. 480Y/277 V, 3 Phase, 4 Wire System:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

4) Neutral/Grounded: Gray.

b. 208Y/120 V, 3 Phase, 4 Wire System:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

4) Neutral/Grounded: White.

c. Equipment Ground, All Systems: Green.

2.3 SINGLE CONDUCTOR BUILDING WIRE

A. Acceptable Manufacturers:

1. Copper Building Wire:

a. Cerro Wire LLC: www.cerrowire.com/#sle.

b. Encore Wire Corporation: www.encorewire.com/#sle.

c. General Cable Technologies Corporation: www.generalcable.com/#sle.

d. Southwire Company: www.southwire.com/#sle.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:

1. Feeders and Branch Circuits:

a. Size 10 AWG and Smaller: Solid.

b. Size 8 AWG and Larger: Stranded.

2. Control Circuits: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:

1. Copper Building Wire: Type THHN/THWN, except as indicated below.

   a. Size 4 AWG and Larger: Type THHN/THWN-2.

   b. Installed Underground: Type XHHW-2.

2.4 ARMORED CABLE

A. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.

B. Conductor Stranding:

   1. Size 10 AWG and Smaller: Solid.

   2. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation: Type THHN.

E. Grounding: Combination of interlocking armor and integral bonding wire.

F. Armor: Steel, interlocked tape.

2.5 METAL-CLAD CABLE

A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

B. Conductor Stranding:

   1. Size 10 AWG and Smaller: Solid.

   2. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

E. Provide dedicated neutral conductor for each phase conductor where indicated or required.

F. Grounding: Full-size integral equipment grounding conductor.

G. Armor: Steel, interlocked tape.

2.6 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

2.7 ACCESSORIES

A. Electrical Tape:

1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil (0.76 mm); suitable for continuous temperature environment up to 194 degrees F (90 degrees C) and short-term 266 degrees F (130 degrees C) overload service.

4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).

5. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil (0.18 mm); suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil (2.3 mm).

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

E. Cable Ties: Material and tensile strength rating suitable for application.

F. Sealing Systems for conductors in ducts entering/exiting from exterior locations: Sealant system for prevention of moisture, gases and rodents from entering building and/or gear via raceways, designed to be used after cable installation.

1. Must be compatible with wide range of cable jacket materials

2. Designed for used with PVC, GRS, EMT, IMC, fiberglass or PR conduit materials

3. Capable of holding up to 22 feet of water head pressure

4. Products:

   a. Polywater; FST Foam Duct Sealant kit (2" conduits and larger)

   b. Polywater; FST Foam Duct Sealant MINI (1.5" conduits and smaller)

   c. Approved equal

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

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

3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.

2. When circuit destination is indicated without specific routing, determine exact routing required.

3. Arrange circuiting to minimize splices.

4. Include circuit lengths required to install connected devices within 10 ft (3.0 m) of location indicated.

5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.

6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.

7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is permitted, under the following conditions:

    a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.

    b. Increase size of conductors as required to account for ampacity derating.

    c. Size raceways, boxes, etc. to accommodate conductors.

8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

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

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install armored cable (Type AC) in accordance with NECA 120.

E. Install metal-clad cable (Type MC) in accordance with NECA 120.

F. Installation in Raceway:

1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.

2. Pull all conductors and cables together into raceway at same time.

3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.

4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.

I. Terminate cables using suitable fittings.

1. Armored Cable (Type AC):

a. Use listed fittings and anti-short, insulating bushings.

b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.

2. Metal-Clad Cable (Type MC):

a. Use listed fittings.

b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.

J. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.

K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet (1.5 m) of slack.

L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

N. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.

2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.

3. Do not remove conductor strands to facilitate insertion into connector.

4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.

5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.

6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.

a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.

b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.

2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.

a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.

b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.

3. Wet Locations: Use heat shrink tubing.

P. Insulate ends of spare conductors using vinyl insulating electrical tape.

Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

R. Identify conductors and cables in accordance with Section 26 05 53.

S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

T. Install sealant within conduits entering/exiting from exterior or underground to prevent intrusion of moisture, gasses and rodents to building and/or gear.

U. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is only required for conductors larger than No. 4 AWG. The resistance test for parallel conductors listed as optional is required.

1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

1.2 RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 467 - Grounding and Bonding Equipment Current Edition, Including All Revisions.

1.4 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.

2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

E. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.

a. Provide continuous grounding electrode conductors without splice or joint.

b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.

2. Metal Underground Water Pipe(s):

a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet (3.0 m) at an accessible location not more than 5 feet (1.5 m) from the point of entrance to the building.

b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.

c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.

3. Concrete-Encased Electrode:

a. Provide connection to concrete-encased electrode consisting of not less than 20 feet (6.0 m) of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.

4. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

F. Service-Supplied System Grounding:

1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system, sized in accordance with

NEC Table 250.66. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.

2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed, sized in accordance with NEC Table 250.102 or at 12.5% of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors where ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

G. Separately Derived System Grounding:

1. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.

2. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.

3. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.

4. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

H. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.

2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.

3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.

4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:

   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.

   b. Metal gas piping. Caution must be taken when grounding gas lines. Coordinate with gas company.

8. Provide bonding for metal building frame.

I. Communications Systems Grounding and Bonding:

1. Provide bonding jumper in raceway from building grounding electrode system to each communications room or backboard and provide ground bar for termination.

   a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.

   b. Raceway Size: 3/4 inch (21 mm) trade size unless otherwise indicated or required.

   c. Ground Bar Size: 1/4 by 2 by 12 inches (6 by 50 by 300 mm) unless otherwise indicated or required.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.

2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:

1. Use insulated copper conductors unless otherwise indicated.

   a. Exceptions:

      1) Use bare copper conductors where installed underground in direct contact with earth.

      2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.

2. Unless otherwise indicated, use exothermic welded connections or compression connectors for underground, concealed and other inaccessible connections.

3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.

2. Size: As indicated.

3. Holes for Connections: As indicated or as required for connections to be made.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.

2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.

3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.

4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.

5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

D. Identify grounding and bonding system components in accordance with Section 26 05 53.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.

C. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

D. Section 26 05 36 - Cable Trays for Electrical Systems: Additional support and attachment requirements for cable tray.

E. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

F. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

G. Section 26 25 13 - Low-Voltage Busways: Additional support and attachment requirements for busway.

H. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

I. Section 26 56 00 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.3 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.

D. MFMA-4 - Metal Framing Standards Publication 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.

2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

D. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

E. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.

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

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

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

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

D. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

E. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

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

2. Provide products listed, classified, and labeled by Underwriters Laboratories (UL) as suitable for the purpose intended, where applicable.

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

4. Do not use products for applications other than as permitted by NFPA 70 and product listing.

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

6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.

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

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

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.

1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.

2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

1. Comply with MFMA-4.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

F. Anchors and Fasteners:

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

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

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

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

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

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

D. Provide independent support from building structure. Do not provide support from piping, ductwork, low voltage cable tray systems, or other systems.

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

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

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

H. Field-Welding (where approved by Architect): Comply with Section 05 50 00.

I. Equipment Support and Attachment:

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

2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.

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

4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 30 00.

5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

J. Conduit Support and Attachment: Also comply with Section 26 05 33.13.

K. Cable Tray Support and Attachment: Also comply with Section 26 05 36.

L. Box Support and Attachment: Also comply with Section 26 05 33.16.

M. Busway Support and Attachment: Also comply with Section 26 25 13.

N. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.

O. Exterior Luminaire Support and Attachment: Also comply with Section 26 56 00.

P. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

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

R. Remove temporary supports.

S. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

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

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

END OF SECTION

SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. PVC-coated galvanized steel rigid metal conduit (RMC).

C. Flexible metal conduit (FMC).

D. Liquidtight flexible metal conduit (LFMC).

E. Electrical metallic tubing (EMT).

F. Rigid polyvinyl chloride (PVC) conduit.

G. Conduit fittings.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 07 84 00 - Firestopping.

C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

D. Section 26 05 29 - Hangers and Supports for Electrical Systems.

E. Section 26 05 33.16 - Boxes for Electrical Systems.

F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC) 2020.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S) 2020.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT) 2013.

E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) 2017.

F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.

G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit 2018.

H. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing 2021.

I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 6 - Electrical Rigid Metal Conduit-Steel Current Edition, Including All Revisions.

K. UL 514B - Conduit, Tubing, and Cable Fittings Current Edition, Including All Revisions.

L. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.

4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Submit all items in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

D. Shop Drawings:

1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.

2. Include proposed locations of roof penetrations and proposed methods for sealing.

E. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).

2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.

3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.

4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.

5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.

D. Embedded Within Concrete:

1. Within Slab on Grade: Not permitted.

E. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

F. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

G. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.

1. Maximum Length: 6 feet (1.8 m) from outlet box. Do not daisy chain.

H. Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit.

2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.

3. Maximum Length: 6 feet (1.8 m) unless otherwise indicated.

4. Vibrating equipment includes, but is not limited to:

a. Transformers.

b. Motors.

2.2 CONDUIT REQUIREMENTS

A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.

C. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 1/2 inch (16 mm) trade size.

2. Control Circuits: 1/2 inch (16 mm) trade size.

3. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.

4. Underground, Exterior: 1 inch (27 mm) trade size.

D. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2. Material: Use steel.

3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil (1.02 mm).

C. PVC-Coated Fittings:

1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.

2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.

3. Material: Use steel or malleable iron.

4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil (1.02 mm).

D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil (0.38 mm).

2.5 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2. Material: Use steel or malleable iron.

2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2. Material: Use steel or malleable iron.

2.7 ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2. Material: Use steel.

3. Connectors and Couplings: Use compression (gland) or set-screw type.

a. Do not use indenter type connectors and couplings.

2.8 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.

2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

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

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

E. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

F. Install electrical nonmetallic tubing (ENT) in accordance with NECA 111.

G. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.

H. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.

2. When conduit destination is indicated without specific routing, determine exact routing required.

3. Conceal all conduits unless specifically indicated to be exposed.

4. Conduits in the following areas may be exposed, unless otherwise indicated:

a. Electrical rooms.

b. Mechanical equipment rooms.

c. Within joists in areas with no ceiling.

5. Unless otherwise approved, do not route conduits exposed:

a. Across floors.

b. Across roofs.

c. Across top of parapet walls.

d. Across building exterior surfaces.

6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.

7. Arrange conduit to maintain adequate headroom, clearances, and access.

8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.

9. Arrange conduit to provide no more than 150 feet (46 m) between pull points.

10. Route conduits above water and drain piping where possible.

11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.

12. Maintain minimum clearance of 6 inches (150 mm) between conduits and piping for other systems.

13. Maintain minimum clearance of 12 inches (300 mm) between conduits and hot surfaces. This includes, but is not limited to:

    a. Heaters.

    b. Hot water piping.

    c. Flues.

14. Group parallel conduits in the same area together on a common rack.

I. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.

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

3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.

4. Use conduit strap to support single surface-mounted conduit.

    a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.

5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.

6. Use conduit clamp to support single conduit from beam clamp or threaded rod.

7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.

8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).

9. Use of spring steel conduit clips for support of conduits is not permitted.

    a. Support of electrical metallic tubing (EMT) up to 1 inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.

10. Use of wire for support of conduits is not permitted.

11. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

J. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.

2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.

3. Use suitable adapters where required to transition from one type of conduit to another.

4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.

5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.

7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.

8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

K. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.

2. Make penetrations perpendicular to surfaces unless otherwise indicated.

3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.

4. Conceal bends for conduit risers emerging above ground.

5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.

6. Provide suitable modular seal where conduits penetrate exterior wall below grade. All bolts, nuts and fasteners shall be steel with 2-part Dichromate corrosions inhibiting coating or Type 316 Stainless steel.

7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.

8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.

9. Provide metal escutcheon plates for conduit penetrations exposed to public view.

10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

L. Underground Installation:

1. Minimum Cover, Unless Otherwise Indicated or Required:

a. Underground, Exterior: 24 inches (610 mm).

b. Under Slab on Grade: 12 inches (300 mm) to bottom of slab.

2. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.

M. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches (76 mm) on all sides unless otherwise indicated.

N. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.

O. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.

2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.

3. Where conduits are subject to earth movement by settlement or frost.

P. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from outdoors into conditioned interior spaces.

2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

3. Where conduits penetrate coolers or freezers.

Q. Install sealant within conduits entering/exiting from exterior or underground to prevent intrusion of moisture, gasses and rodents to building and/or gear.

R. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches (300 mm) at each end.

S. Provide grounding and bonding in accordance with Section 26 05 26.

T. Identify conduits in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

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

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 05 33.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches (1,650 cu cm), including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).

C. Floor boxes.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 07 84 00 - Firestopping.

C. Section 08 31 00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

E. Section 26 05 29 - Hangers and Supports for Electrical Systems.

F. Section 26 05 33.13 - Conduit for Electrical Systems:

1. Conduit bodies and other fittings.

2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.

G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

H. Section 26 27 26 - Wiring Devices:

1. Wall plates.

2. Floor box service fittings.

3. Additional requirements for locating boxes for wiring devices.

I. Section 27 10 00 - Structured Cabling System: Additional requirements for communications systems outlet boxes.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.

E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports 2013 (Reaffirmed 2020).

F. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports 2013 (Reaffirmed 2020).

G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.

J. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.

K. UL 514A - Metallic Outlet Boxes Current Edition, Including All Revisions.

L. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.

4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.

5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.

6. Coordinate the work with other trades to preserve insulation integrity.

7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.

8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for junction and pull boxes and cabinets and enclosures.

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

D. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, and cabinets and enclosures.

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.

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

4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches (1,650 cu cm), Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.

2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.

3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit is used.

4. Use nonmetallic boxes where exposed rigid PVC conduit is used.

5. Use suitable concrete type boxes where flush-mounted in concrete.

6. Use suitable masonry type boxes where flush-mounted in masonry walls.

7. Use raised covers suitable for the type of wall construction and device configuration where required.

8. Use shallow boxes where required by the type of wall construction.

9. Do not use "through-wall" boxes designed for access from both sides of wall.

10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.

11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.

12. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.

13. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.

14. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.

15. Minimum Box Size, Unless Otherwise Indicated:

    a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.

    b. Communications Systems Outlets: Comply with Section 27 10 00.

    c. Ceiling Outlets: 4 inch octagonal or square by 2-1/8 inch deep (100 by 54 mm) trade size.

16. Wall Plates: Comply with Section 26 27 26.

17. Manufacturers:

    a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.

    b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.

    c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.

    d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.

    e. Thomas & Betts Corporation: www.tnb.com/#sle.

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

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):

1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.

2. NEMA 250 Environment Type, Unless Otherwise Indicated:

    a. Indoor Clean, Dry Locations: Type 1, painted steel.

    b. Outdoor Locations: Type 3R, painted steel.

3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):

    a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

    b. Boxes 6 square feet (0.56 sq m) and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:

a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.

b. Back Panels: Painted steel, removable.

c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.

5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

6. Manufacturers:

a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.

b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.

c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.

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

D. Floor Boxes:

1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.

2. Use cast iron floor boxes within slab on grade.

3. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).

4. Manufacturer: Same as manufacturer of floor box service fittings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

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

3.2 INSTALLATION

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

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide separate boxes for emergency power and normal power systems.

E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations:

1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.

2. Unless dimensioned, box locations indicated are approximate.

3. Locate boxes as required for devices installed under other sections or by others.

a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.

b. Communications Systems Outlets: Comply with Section 27 10 00.

4. Locate boxes so that wall plates do not span different building finishes.

5. Locate boxes so that wall plates do not cross masonry joints.

6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.

7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches (150 mm) horizontal separation unless otherwise indicated.

8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches (610 mm) horizontal separation.

9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.

a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches (610 mm) separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.

b. Do not install flush-mounted boxes with area larger than 16 square inches (0.0103 sq m) or such that the total aggregate area of openings exceeds 100 square inches (0.0645 sq m) for any 100 square feet (9.29 sq m) of wall area.

10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.

11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:

a. Concealed above accessible suspended ceilings.

b. Within joists in areas with no ceiling.

c. Electrical rooms.

d. Mechanical equipment rooms.

I. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.

2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6 mm) or does not project beyond finished surface.

2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.

3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch (3 mm) at the edge of the box.

L. Floor-Mounted Cabinets: Mount on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 30 00.

M. Install boxes as required to preserve insulation integrity.

N. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

O. Nonmetallic Floor Boxes: Cut box flush with finished floor after concrete pour.

P. Underground Boxes/Enclosures:

1. Install enclosure on gravel base, minimum 6 inches (150 mm) deep.

2. Flush-mount enclosures located in concrete or paved areas.

3. Mount enclosures located in landscaped areas with top at 1 inch (25 mm) above finished grade.

4. Provide cast-in-place concrete collar constructed in accordance with Section 03 30 00, minimum 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep), around enclosures that are not located in concrete areas.

5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

Q. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

S. Close unused box openings.

T. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

U. Provide grounding and bonding in accordance with Section 26 05 26.

V. Identify boxes in accordance with Section 26 05 53.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Underground warning tape.

E. Warning signs and labels.

1.2 RELATED REQUIREMENTS

A. Section 09 91 13 - Exterior Painting.

B. Section 09 91 23 - Interior Painting.

C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

D. Section 26 05 73 - Power System Analysis: Arc flash hazard warning labels.

E. Section 26 27 26 - Wiring Devices: Device and wall plate finishes; factory pre-marked wall plates.

F. Section 27 10 00 - Structured Cabling System: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 969 - Marking and Labeling Systems Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.

2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Submit all items in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.

D. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

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

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.

a. Switchboards:

1) Identify power source and circuit number where power originates. Include location when not within sight of equipment.

2) Use identification nameplate to identify main overcurrent protective device.

3) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.

b. Panelboards:

1) Identify power source and circuit number where power originates. Include location when not within sight of equipment.

2) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.

3) For power panelboards at a door, use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.

c. Transformers:

1) Identify power source and circuit number where power originates. Include location when not within sight of equipment.

2) Identify load(s) served. Include location.

d. Enclosed switches, circuit breakers, and motor controllers (including variable frequency motor controllers):

1) Identify power source and circuit number where power originates. Include location.

2) Identify load(s) served. Include location.

e. Enclosed Contactors:

1) Identify load(s) and associated circuits controlled. Include location.

f. Centralized Emergency Lighting Inverters:

1) Identify power source and circuit number for normal power source. Include location.

g. Transfer Switches:

1) Identify power source and circuit number for both normal power source and standby power source. Include location.

2) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.

2. Service Equipment:

a. Use identification nameplate to identify each service disconnecting means.

b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and

branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.

3. Emergency System Equipment:

   a. Use identification nameplate to identify emergency system equipment in accordance with NFPA 70.

   b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.

4. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.

   a. Service equipment.

5. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.

B. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.

2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

C. Identification for Raceways:

1. Use color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet (6.1 m).

   a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches (76 mm) wide.

      1) Color Code:

         (a) Emergency Power System: Red.

      2) Field-Painting: Comply with Section 09 91 23 and 09 91 13.

      3) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.

D. Identification for Boxes:

1. Use color coded boxes to identify systems other than normal power system.

   a. Color-Coded Boxes: Field-painted in accordance with Section 09 91 23 and 09 91 13 per the same color code used for raceways.

1) Emergency Power System: Red.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:

a. Indoor Clean, Dry Locations: Use plastic nameplates.

b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.

2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch (1.6 mm); engraved text.

3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.

4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.

5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.

2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

2.3 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:

1. Materials:

2. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.

C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.

2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.

3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

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

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.

2. Flush-Mounted Equipment: Inside of equipment door.

3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.

4. Elevated Equipment: Legible from the floor or working platform.

5. Branch Devices: Adjacent to device.

6. Interior Components: Legible from the point of access.

7. Conduits: Legible from the floor.

8. Boxes: Outside face of cover.

9. Conductors and Cables: Legible from the point of access.

10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 05 73
POWER SYSTEM ANALYSIS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or a professional electrical engineering firm.

B. The studies shall include all new electrical distribution equipment supplied under this contract.

1. Include emergency power system distribution equipment.

2. Include all directly affected existing distribution equipment at the customer facility. (First panel downstream of new equipment)

1.2 RELATED REQUIREMENTS

A. Section 26 05 00 - Common Work Results For Electrical

B. Section 26 24 13 - Switchboards

C. Section 26 24 16 - Panelboards

1.3 REFERENCE STANDARDS

A. IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings 1990 (Reaffirmed 1997).

B. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems 2001, with Errata (2003).

C. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis 1997.

D. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations 2018, with Errata (2019).

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 70E - Standard for Electrical Safety in the Workplace 2021.

1.4 SUBMITTALS

A. Submittals for Review/Approval

1. Submit a short-circuit and protective device coordination study to the design engineer prior to receiving final approval of the shop drawings and/or prior to release of

equipment drawings for manufacturing. The study shall provide data to ensure that the selection of equipment will have adequate ratings and the protective device trip characteristics will be satisfactory. Contractor to use estimated feeder lengths at this stage.

2. Submit the final short-circuit and protective device coordination analysis at the end of the construction cycle when circuits are installed and all equipment is on site and/or installed such that complete and accurate data may be obtained.

B. Submittals for Construction

1. The results of the final short-circuit and protective device coordination analysis studies shall be summarized in a final report. Submit the study in color coded and searchable PDF format.

2. At the owner's option, the contractor is required to provide the study project files to the Owner in electronic format including all project files, libraries, etc to allow the owner to update and to print additional copies, labels, etc.

3. If the owner does not use the applicable computer program, a copy of the computer analysis software viewer program is required to accompany the electronic project files, to allow the Owner to review all aspects of the project and print arc flash labels, one line diagrams, etc.

4. The report shall include the following sections:

   a. Executive Summary.

   b. Descriptions, purpose, basis and scope of the study.

   c. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties.

   d. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, and fuse selection.

   e. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.

   f. Details of the incident energy and flash protection boundary calculations.

   g. Recommendations for system improvements, where needed.

   h. Impedance one line diagram.

   i. ANSI Fault study one line with branch fault current flow.

   j. Equipment specific arc flash labels.

5. If the power systems study submittal is not approved following the second submittal, the contractor shall pay the Project Engineer $200.00 per hour to review additional submittals until the study is approved.

1.5 QUALIFICATIONS

A. The short-circuit and protective device coordination analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the electrical equipment manufacturer or a professional electrical engineering firm.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

1.6 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) software program. Other commercially available products may be considered under certain circumstances.

PART 2 - PRODUCT

2.1 STUDIES

A. Furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or a professional electrical engineering firm.

2.2 DATA COLLECTION

A. Electrical Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination, and arc flash hazard analysis studies (if required) shall furnish the Electrical Contractor with a list of required data immediately after award of the contract. The Electrical Contractor shall expedite collection of the data to ensure completion of the studies as required.

B. The engineer performing the study shall make at least one job site visit before completion of the final study to familiarize himself/herself with the project to ensure that the provided data is accurate.

C. Source contribution shall include present and future motors and generators.

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 STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141.

B. Estimated conductor lengths, typical generator, transformer, motor, and utility data may be used for the preliminary study.

C. Actual installed conductor lengths, test and/or nameplate data for all generators, transformers, motors 50 HP and larger, capacitors, reactors, or other equipment that may affect the study must be used for the final study.

D. Actual utility fault current and X/R ratio shall be used. Infinite bus calculation is not acceptable.

E. The pre-fault bus voltage shall be the highest reported by the utility for past 5 years. If unavailable, 1.05 per unit shall be used.

F. Provide the following:

1. Calculation methods and assumptions.

2. Selected base per unit quantities.

3. One line diagram of the system being evaluated.

4. Utility impedance data, including the maximum and minimum 3 phase and line-to-ground fault current available, nominal, maximum, and minimum voltage, 3 phase X/R ratio, and line-to-ground X/R ratio.

5. Utility protective device settings including recloser if used.

6. Motor fault contribution characteristics.

7. Generator fault contribution characteristics.

8. Tabulations of calculated quantities.

9. Results, conclusions, and recommendations.

G. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply termination point

2. Incoming switchgear

3. Unit substation primary and secondary terminals

4. Low voltage switchgear.

5. Motor control centers.

6. Standby generators and automatic transfer switches.

7. Branch circuit panelboards.

8. Other significant locations throughout the system.

H. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

I. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings.

2. Adequacy of switchgear, switchboards, disconnects, transfer switches, motor control centers, and panelboard bus bars to withstand short-circuit stresses.

3. Notify Owner, in writing, of any existing circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs. No more than 5 devices shall be shown on any plot.

B. Include on each TCC graph, a complete title, applicable notes, and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device.

2. Medium voltage equipment overcurrent relays.

3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.

5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves. The frequent fault portion of the damage curve should not be shown unless the transformer feeds overhead lines. The shifted curve for line-to-ground faults on the secondary side shall be shown on the ground fault plot.

6. Conductor damage curves.

7. Ground fault protective devices shall be shown on separate TCC plots. The first phase overcurrent relay and any negative sequence relays on the primary side of a delta-wye transformer shall be shown.

8. Pertinent motor starting characteristics, motor damage points, and overload relay. Motors larger than 500 HP shall have a thermal damage curve.

9. Pertinent generator short-circuit decrement curve and generator damage point. Generators larger than 1250 kW shall have a thermal damage curve.

10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed in accordance to IEEE 1584.

B. The Engineer performing this study shall meet with the Design Engineer of Record and the Owner to discuss different operating configuration of the power system and which one would be considered the "normal operating configuration" that is, which one is power system in most of the time. Marking of the equipment shall be from the results of the "normal operating configuration" study with the results of other configurations supplied in the report. An additional standard label stating that the results on the label are good only for the "normal operating configuration" shall be place next to the Arc Flash label.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters, variable frequency drives, UPS, electrical equipment associated with mechanical equipment, etc), where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

E. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

F. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

G. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the

maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off).

H. Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

I. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.

2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

J. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

K. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

L. Miss-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

M. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).

2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, KVA rating, impedance, % taps and phase shift.

3. Reactor data, including voltage rating, and impedance.

4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.

5. Motor contribution data (induction motors and synchronous motors), including short circuit reactance, rated horsepower or KVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

   a. Voltage

   b. Calculated fault current magnitude and angle

   c. Fault point X/R ratio

   d. Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

   a. Voltage

   b. Calculated symmetrical fault current magnitude and angle

   c. Fault point X/R ratio

   d. Calculated asymmetrical fault currents

3. Based on fault point X/R ratio

4. Based on calculated symmetrical value multiplied by 1.6

5. Based on calculated symmetrical value multiplied by 2.7

   a. Equivalent impedance

6. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

a. Voltage

b. Calculated symmetrical fault current magnitude and angle

c. Fault point X/R ratio

d. No AC Decrement (NACD) Ratio

e. Equivalent impedance

f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis

g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

7. Equipment evaluation table including but not limited to AIC rating, X/R ratio, actual fault current, percent of actual to rated fault current, derated value.

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:

a. Current transformer ratio

b. Current setting

c. Time setting

d. Instantaneous setting

e. Recommendations on improved relaying systems, if applicable.

2. Special purpose relays

a. Provide settings for all functions provided by special purpose relays such differential, reverse power, directional overcurrent, negative sequence, current unbalance, and multi-function relays for main and tie circuit breakers, generator management, transformer protection, feeder protection, motor protection, etc

3. Circuit Breakers:

a. Adjustable pickups and time delays (long time, short time, ground)

b. Adjustable time-current characteristic

c. Adjustable instantaneous pickup

d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude

2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the electrical contractor in conjunction with Power Systems Analysis engineer.

B. Make minor modifications to equipment as required to provide for conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

A. The engineer of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in., unless directed otherwise by owner, thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be provided to owner after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system.

C. All labels shall be based on recommended overcurrent device settings and the incident energy available as calculated under the "normal operating configuration", not the worst case scenario.

D. The label shall include the following information, at a minimum:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category

5. Incident energy

6. Working distance

7. Engineering report number, revision number and issue date.

E. Labels shall be machine printed, with no field markings.

F. Arc flash labels shall be provided for the following equipment as a minimum:

1. For each 600, 480 and applicable 208 volt panelboard, provide one arc flash label.

2. For each motor control center, provide one arc flash label. If the MCC has a main breaker, provide two labels, one for line side compartments and one for load side compartments.

3. For each low voltage switchboard, provide one arc flash label. If the switchboard has a main breaker or fuse, provide two labels, one for line side compartments and one for load side compartments.

4. For each switchgear, provide one arc flash label. If the switchgear has a main breaker or fuse, provide two labels, one for line side compartments and one for load side compartments.

5. For medium voltage switches, provide one arc flash label. If the switch has a main breaker or fuse, provide two labels, one for line side compartments and one for load side compartments.

6. For all other electrical and mechanical equipment specified in 2.05(B), provide one arc flash label.

7. Where equipment is fed from an emergency source and results in a higher incident energy level, provide two labels, one for the normal source and one for the emergency source.

G. Labels shall be field installed by the electrical contractor in conjunction with the Arc Flash Study engineer.

3.3 ARC FLASH TRAINING

A. The engineer of the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Occupancy sensors.

B. Daylighting controls.

1.2 RELATED REQUIREMENTS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems

B. Section 26 05 33.16 - Boxes for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.

1.3 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices current edition.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.

D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 1472 - Solid-State Dimming Controls Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.

2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.

3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.

4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.

5. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items except field quality related items and O/M documentation, in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

D. Shop Drawings:

1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.

2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.

E. Field Quality Control Reports.

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

G. Operation and Maintenance Data: Include detailed information on device programming and setup.

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. Extra Locking Receptacle-Mounted Outdoor Photo Controls: Five percent of total quantity installed for each type, but not less than two of each type.

I. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

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

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all occupancy sensors.

C. Provide five year manufacturer warranty for utility grade locking receptacle-mounted outdoor photo controls.

D. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.2 OCCUPANCY SENSORS

A. All Occupancy Sensors:

1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.

2. Sensor Technology:

   a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.

   b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.

   c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.

   d. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.

3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.

4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.

5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.

6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.

7. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.

8. Compatibility (Non-Dimming Sensors): Suitable for controlling specified fixtures.

9. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.

10. Where wired sensors are indicated, wireless sensors are acceptable provided that all components and wiring modifications necessary for proper operation are included.

11. Wireless Sensors:

    a. RF Range: 30 feet (9 m) through typical construction materials.

b. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B application.

c. Power: Battery-operated with minimum ten-year battery life.

B. Wall Switch Occupancy Sensors:

1. All Wall Switch Occupancy Sensors:

a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.

b. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.

2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet (83.6 sq m).

3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet (37.2 sq m).

4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet (83.6 sq m).

C. Wall Dimmer Occupancy Sensors:

1. General Requirements:

a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability , and no leakage current to load in off mode.

b. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.

2. Passive Infrared (PIR) Wall Dimmer Occupancy Sensors: Capable of detecting motion within an area of 900 square feet (83.6 sq m).

D. Ceiling Mounted Occupancy Sensors:

1. All Ceiling Mounted Occupancy Sensors:

a. Description: Low profile occupancy sensors designed for ceiling installation.

b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.

2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:

3. Ultrasonic Ceiling Mounted Occupancy Sensors:

4. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:

E. Power Packs for Low Voltage Occupancy Sensors:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.

2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.

3. Input Supply Voltage: Dual rated for 120/277 V ac.

4. Load Rating: As required to control the load indicated on drawings.

F. Power Packs for Wireless Occupancy Sensors:

1. Description: Plenum rated, self-contained relay compatible with specified wireless occupancy sensors for switching of line voltage loads.

2. Input Supply Voltage: Dual rated for 120/277 V ac.

2.3 DAYLIGHTING CONTROLS

A. System Description: Control system consisting of photo sensors and compatible control modules and power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.

B. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.

1. Sensor Type: Filtered silicon photo diode.

2. Sensor Range:

a. Indoor Photo Sensors: 5 to 100 footcandles (53.8 to 1,080 lx).

b. Skylight Photo Sensors: 1,000 to 6,000 footcandles (10,760 to 64,580 lx).

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

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

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of lighting control devices provided under this section.

1. Mounting Heights: Unless otherwise indicated, as follows:

   a. Wall Switch Occupancy Sensors: 48 inches (1.2 m) above finished floor.

   b. In-Wall Time Switches: 48 inches (1.2 m) above finished floor.

   c. In-Wall Interval Timers: 48 inches (1.2 m) above finished floor.

2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.

3. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches (80 mm) from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.

C. Install lighting control devices in accordance with manufacturer's instructions.

D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

1. Do not utilize equipment grounding conductor as a current carrying conductor for electronic switching/dimming/sensor devices.

2. Include a grounded (neutral) conductor with switch leg.

E. Install lighting control devices plumb and level, and held securely in place.

F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.

G. Provide required supports in accordance with Section 26 05 29.

H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

I. Identify lighting control devices in accordance with Section 26 05 53.

J. Occupancy Sensor Locations:

1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect.

2. Location Adjustments: Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage.

3. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.

4. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet (1.2 m) from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

K. Outdoor Photo Control Locations:

1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.

2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

L. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.

M. Daylighting Control Photo Sensor Locations:

1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect.

2. Location Adjustments: Within the design intent, reasonably minor adjustments to locations may be made in order to optimize control and avoid conflicts or problems affecting proper detection of light levels.

3. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for proper control of respective room or area based on manufacturer's recommendations for installed devices.

4. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.

5. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.

N. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

O. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

P. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

Q. Where indicated or required, provide cabinet or enclosure in accordance with Section 26 05 33.16 for mounting of lighting control device system components.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each lighting control device for damage and defects.

C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

D. Test time switches to verify proper operation.

E. Test outdoor photo controls to verify proper operation, including time delays where applicable.

F. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.

G. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.

C. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.

D. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

E. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect. Record settings in written report to be included with submittals.

F. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.

G. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 COMMISSIONING

A. See Section 01 91 13 - General Commissioning Requirements for commissioning requirements.

END OF SECTION

SECTION 26 22 00
LOW VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General purpose transformers.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 33.13 - Conduit for Electrical Systems: Flexible conduit connections.

E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers Current Edition.

B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers 2015.

C. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers 2013.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers 2015.

F. NEMA ST 20 - Dry-Type Transformers for General Applications 2014.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.

I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 506 - Standard for Specialty Transformers Current Edition, Including All Revisions.

K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate the work with placement of supports, anchors, etc. required for mounting.

4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items except field quality related items and O/M documentation, in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.

1. Vibration Isolators: Include attachment method and rated load and deflection.

2. K-factor Rated Transformers: Include K-factor ratings.

3. Buck-boost Transformers: Include voltage selection tables and wiring diagrams for autotransformer configurations.

4. Shielded Transformers: Include shielding method and noise attenuation performance.

5. Small Power Centers: Include panelboard bus ampacity, integrated short circuit ampere rating, and circuit breaker sizes and ampere ratings.

D. Shop Drawings: Provide dimensioned plan and elevation views of transformers and adjacent equipment with all required clearances indicated.

1. Small Power Centers: Include panel arrangements.

E. Source Quality Control Test Reports: Include reports for tests designated in NEMA ST 20 as design and routine tests.

F. Field Quality Control Test Reports.

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

H. Maintenance Data: Include recommended maintenance procedures and intervals.

I. Project Record Documents: Record actual locations of transformers.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed the following maximum temperatures during and after installation of transformers.

1. Greater than 10 kVA: 104 degrees F (40 degrees C) maximum.

2. Less than 10 kVA: 77 degrees F (25 degrees C) maximum.

1.9 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

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

F. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:

1. Altitude: Less than 3,300 feet (1,000 m).

2. Ambient Temperature:

a. Greater than 10 kVA: Not exceeding 104 degrees F (40 degrees C).

b. Less than 10 kVA: Not exceeding 77 degrees F (25 degrees C).

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

I. Energy efficiency: U.S. Department of Energy 10 CFR Part 431, Subpart K "Energy Conservation Standards for Distribution Transformers", as amended in the January 1, 2016 rule.

2.3 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Insulation System and Allowable Average Winding Temperature Rise:

1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.

2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

C. Coil Conductors: Continuous copper windings with terminations brazed or welded.

D. Winding Taps:

1. Less than 3 kVA: None.

2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.

3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.

4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

E. Energy Efficiency: Comply with DOE 10 CFR 431 Subpart K.

F. Sound Levels: Standard sound levels complying with NEMA ST 20

G. Mounting Provisions:

1. Less than 15 kVA: Suitable for wall mounting.

2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.

3. Larger than 75 kVA: Suitable for floor mounting.

H. Transformer Enclosure: Comply with NEMA ST 20.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

2. Construction: Steel.

a. Less than 15 kVA: Totally enclosed, non-ventilated.

b. 15 kVA and Larger: Ventilated.

3. Finish: Manufacturer's standard grey, suitable for outdoor installations.

4. Provide lifting eyes or brackets.

2.4 SOURCE QUALITY CONTROL

A. Factory test transformers according to NEMA ST 20.

B. Sound Level Tests: Perform factory test designated in NEMA ST 20 as "design" test on each production unit.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

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

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

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

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 26 05 33.13, 2 feet (600 mm) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Install transformers plumb and level.

G. Transformer Support:

1. Provide required support and attachment in accordance with Section 26 05 29, where not furnished by transformer manufacturer.

2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.

3. Unless otherwise indicated, mount floor-mounted transformers on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03 30 00.

4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

K. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.

L. Identify transformers in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.

1. 167 kVA single phase, 500 kVA three phase and smaller:

a. Perform turns ratio tests at all tap positions.

2. Larger than 167 kVA single phase and 500 kVA three phase:

a. Verify that control and alarm settings on temperature indicators are as specified.

b. Perform excitation-current tests on each phase.

c. Measure the resistance of each winding at each tap connection.

d. Perform an applied voltage test on all high- and low-voltage windings-to-ground.

3.4 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 05 73 - Power System Analysis.

F. Section 26 28 13 - Fuses: Fuses for fusible switches.

1. Includes requirements for spare fuses and spare fuse cabinets.

G. Section 26 43 13 - Low Voltage AC Surge Protection Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e (Amended 2017).

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers 2016.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

D. NECA 400 - Standard for Installing and Maintaining Switchboards 2007.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

F. NEMA PB 2 - Deadfront Distribution Switchboards 2011.

G. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less 2013.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.

I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.

K. UL 869A - Reference Standard for Service Equipment Current Edition, Including All Revisions.

L. UL 891 - Switchboards Current Edition, Including All Revisions.

M. UL 1053 - Ground-Fault Sensing and Relaying Equipment Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:

1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.

2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.

3. Obtain Utility Company approval of switchboard prior to fabrication.

4. Preinstallation Meeting: Convene one week prior to commencing work of this section to review requirements with Utility Company representative.

5. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items except field quality related items and O/M documentation, in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

D. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.

2. Include wiring diagrams showing all factory and field connections.

3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

4. Include documentation of listed series ratings upon request.

5. Include documentation demonstrating selective coordination upon request.

E. Service Entrance Switchboards: Include documentation of Utility Company approval of switchboard.

F. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 2 as production (routine) tests.

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

H. Field Quality Control Test Reports.

I. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.

J. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. Enclosure Keys: Two of each different key.

3. Electronic Trip Circuit Breakers: Provide one portable test set.

4. See Section 26 28 13 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

D. Products: Listed, classified, and labeled by Underwriters Laboratories Inc. or testing firm acceptable to authorities having jurisdiction as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Switchboards:

1. ABB/GE: www.electrification.us.abb.com/#sle.

2. Eaton Corporation: www.eaton.com/#sle.

3. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

4. Siemens Industry, Inc: www.usa.siemens.com/#sle.

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

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

D. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Front-Connected Switchboards:

1. Main Device(s): Individually-mounted.

2. Feeder Devices: Panel/group-mounted.

3. Arrangement: Front accessible only (not rear accessible), rear aligned.

4. Gutter Access: Bolted covers.

E. Service Entrance Switchboards:

1. Listed and labeled as suitable for use as service equipment according to UL 869A.

2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.

3. Comply with Utility Company requirements for electrical service.

F. Service Conditions:

1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:

a. Altitude: Less than 6,600 feet (2,000 m).

b. Ambient Temperature:

1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

2) Switchboards Containing Fusible Switches: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).

2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

G. Short Circuit Current Rating:

1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

H. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

I. Bussing: Sized in accordance with UL 891 temperature rise requirements.

1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.

2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.

3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

4. Phase and Neutral Bus Material: Copper.

5. Ground Bus Material: Copper.

J. Conductor Terminations: Suitable for use with the conductors to be installed.

1. Line Conductor Terminations:

a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

b. Main and Neutral Lug Type: Mechanical.

2. Load Conductor Terminations:

a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

b. Lug Type:

K. Enclosures:

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).

b. Outdoor Locations: Type 3R.

2. Finish: Manufacturer's standard unless otherwise indicated.

L. Future Provisions:

1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

M. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list switchboards as a complete assembly including surge protective device.

N. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.

2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.

a. Use zero sequence or residual ground fault detection method unless otherwise indicated.

b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

O. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

P. Owner Metering:

1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.

2. Measured Parameters:

a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.

b. Current (Amps): For each phase and neutral.

c. Frequency (Hz).

d. Real power (kW): For each phase, 3-phase total.

e. Reactive power (kVAR): For each phase, 3-phase total.

f. Apparent power (kVA): For each phase, 3-phase total.

g. Power factor.

h. Real energy (kWh).

i. Reactive energy (kVARh).

j. Apparent energy (kVAh).

k. Current demand.

l. Power demand: Real, reactive, and apparent.

3. Meter Accuracy: Plus/minus 1.0 percent.

Q. Instrument Transformers:

1. Comply with IEEE C57.13.

2. Select suitable ratio, burden, and accuracy as required for connected devices.

3. Current Transformers: Connect secondaries to shorting terminal blocks.

4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:

1. Interrupting Capacity:

a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.

b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

2. Molded Case Circuit Breakers:

   a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

   b. Minimum Interrupting Capacity:

   c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

      1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

   d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

      1) Provide the following field-adjustable trip response settings:

         (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

         (b) Long time delay.

         (c) Short time pickup and delay.

         (d) Instantaneous pickup.

         (e) Ground fault pickup and delay where ground fault protection is indicated.

      2) Provide zone selective interlocking capability, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.

   e. Provide the following features and accessories where indicated or where required to complete installation:

      1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

3. Insulated Case Circuit Breakers:

   a. Description: Quick-make, quick-break, trip-free circuit breakers with two-step stored energy closing mechanism; standard 80 percent rated unless otherwise indicated; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.

b. Trip Units: Solid state, microprocessor-based, true rms sensing.

1) Provide the following field-adjustable trip response settings:

(a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

(b) Long time delay.

(c) Short time pickup and delay.

(d) Instantaneous pickup.

(e) Ground fault pickup and delay where ground fault protection is indicated.

2) Provide zone selective interlocking capability, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.

2.4 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:

1. Dielectric tests.

2. Mechanical operation tests.

3. Grounding of instrument transformer cases test.

4. Electrical operation and control wiring tests, including polarity and sequence tests.

5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchboards.

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

3.2 INSTALLATION

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

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch (10 mm) between switchboard and wall.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install switchboards plumb and level.

G. Unless otherwise indicated, mount switchboards on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03 30 00.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Install all field-installed devices, components, and accessories.

J. Provide fuses complying with Section 26 28 13 for fusible switches as indicated.

K. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73.

M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

N. Provide filler plates to cover unused spaces in switchboards.

O. Identify switchboards in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

C. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

D. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

E. Inspect and test in accordance with NETA ATS, except Section 4.

F. Perform inspections and tests listed in NETA ATS, Section 7.1.

G. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than [_____] amperes. Larger than 250 amps. Tests listed as optional are not required.

1. Perform insulation-resistance tests on all control wiring with respect to ground.

2. Test functions of the trip unit by means of secondary injection.

H. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

I. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.

J. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

K. Test shunt trips to verify proper operation.

L. Correct deficiencies and replace damaged or defective switchboards or associated components.

M. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.5 CLEANING

A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

B. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

C. Repair scratched or marred surfaces to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

3.7 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Power distribution panelboards.

B. Lighting and appliance panelboards.

C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 05 73 - Power System Analysis: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

F. Section 26 28 13 - Fuses: Fuses for fusible switches and spare fuse cabinets.

G. Section 26 43 13 - Low Voltage AC Surge Protection Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e (Amended 2017).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NECA 407 - Standard for Installing and Maintaining Panelboards 2015.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts 2008 (Reaffirmed 2020).

F. NEMA PB 1 - Panelboards 2011.

G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less 2013.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.

I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.

K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.

L. UL 67 - Panelboards Current Edition, Including All Revisions.

M. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.

N. UL 869A - Reference Standard for Service Equipment Current Edition, Including All Revisions.

O. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.

P. UL 1053 - Ground-Fault Sensing and Relaying Equipment Current Edition, Including All Revisions.

Q. UL 1699 - Arc-Fault Circuit-Interrupters Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.

4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items except field quality related items and O/M documentation, in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

D. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.

2. Include wiring diagrams showing all factory and field connections.

E. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.

F. Field Quality Control Test Reports.

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

H. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

I. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:

1. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

2. Panelboards Containing Fusible Switches: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ABB/GE: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

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

F. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet (2,000 m).

2. Ambient Temperature:

a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

C. Short Circuit Current Rating:

1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

2. Listed series ratings are not acceptable.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.

2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

3. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Boxes: Galvanized steel unless otherwise indicated.

a. Provide wiring gutters sized to accommodate the conductors to be installed.

b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.

c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.

3. Fronts:

a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 13, list and label panelboards as a complete assembly including surge protective device.

L. Panelboard Contactors: Where panelboard contactors are indicated, provide electrically operated, mechanically held magnetic contactor complying with NEMA ICS 2.

1. Ampere Rating: Not less than ampere rating of panelboard bus.

2. Short Circuit Current Rating: Not less than the panelboard short circuit current rating.

3. Coil Voltage: As required for connection to control system indicated.

M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

N. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

O. Load centers are not acceptable.

P. Provide the following features and accessories where indicated or where required to complete installation:

1. Feed-through lugs.

2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Products:

1. 120/208 or 277/480 volts, 3-phase, 4-wire, molded case circuit breaker type.

a. Eaton Cutler-Hammer type PRL 4b.

b. General Electric "Spectra" series distribution type.

c. Schneider Square D "I-Line" series distribution type

d. Siemens type P4 or P5, depending upon panelboard ampacity

2. Substitutions: Not permitted.

C. Conductor Terminations:

1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

2. Main and Neutral Lug Type: Mechanical.

D. Bussing:

1. Phase and Neutral Bus Material: Copper.

2. Ground Bus Material: Aluminum.

E. Circuit Breakers:

1. Provide bolt-on type.

2. Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 150 amperes.

3. Provide electronic trip circuit breakers for circuit breaker frame sizes 150 amperes and above.

F. Enclosures:

1. Provide surface-mounted enclosures unless otherwise indicated.

2. Fronts: Provide door-in-door trim with fully hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.

3. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Products:

1. 120/208 volts, 3-phase, 4-wire: minimum 10,000 AIC rating.

a. Eaton Cutler-Hammer type PRL 1a.

b. General Electric type AQ.

c. Schneider Square D type NQ

d. Siemens type P1

2. 277/480 volts, 3-phase, 4-wire: minimum 14,000 AIC rating

a. Eaton Cutler-Hammer type PRL 2a or 3a, depending upon AIC rating

b. General Electric type AE

c. Schneider Square D type NF

d. Siemens type P2

3. Substitutions: Not permitted.

C. Conductor Terminations:

1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

2. Main and Neutral Lug Type: Mechanical.

D. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.

2. Phase and Neutral Bus Material: Copper.

3. Ground Bus Material: Aluminum.

E. Circuit Breakers: Thermal magnetic bolt-on type.

F. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.

2. Fronts: Provide door-in-door trim with fully hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.

3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

2. Interrupting Capacity:

a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:

1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.

2) 14,000 rms symmetrical amperes at 480 VAC.

b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

3. Conductor Terminations:

a. Provide mechanical lugs.

b. Provide compression lugs where indicated.

c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 150 amperes and larger.

b. Provide interchangeable trip units for circuit breaker frame sizes 250 amperes and larger.

5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

   a. Provide the following field-adjustable trip response settings:

      1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

      2) Long time delay.

      3) Short time pickup and delay.

      4) Instantaneous pickup.

      5) Ground fault pickup and delay where ground fault protection is indicated.

   b. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.

   c. Provide communication capability where indicated: Compatible with system indicated.

6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

7. Provide the following circuit breaker types where indicated:

   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.

   c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.

   d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.

   e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.

9. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.

10. Do not use tandem circuit breakers.

11. Do not use handle ties in lieu of multi-pole circuit breakers.

12. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.

13. Provide the following features and accessories where indicated or where required to complete installation:

    a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

    b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

    c. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.

    d. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.

    e. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.6 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

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

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

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

C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install panelboards plumb.

G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.

I. Mount floor-mounted power distribution panelboards on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03 30 00.

J. Provide minimum of six spare 1 inch (27 mm) trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling.

K. Provide grounding and bonding in accordance with Section 26 05 26.

1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.

2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

L. Install all field-installed branch devices, components, and accessories.

M. Provide fuses complying with Section 26 28 13 for fusible switches as indicated.

N. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

O. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.

P. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.

Q. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

R. Provide filler plates to cover unused spaces in panelboards.

S. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads listed below:

1. Emergency and night lighting circuits.

2. Fire detection and alarm circuits.

3. Communications equipment circuits.

4. Intrusion detection and access control system circuits.

5. Video surveillance system circuits.

T. Identify panelboards in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and any circuit breakers larger than 225 amperes. Tests listed as optional are not required, except for the following:

1. Perform insulation-resistance tests on all control wiring with respect to ground.

2. Test functions of the trip unit by means of secondary injection.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is required.

E. Test GFCI circuit breakers to verify proper operation.

F. Test AFCI circuit breakers to verify proper operation.

G. Test shunt trips to verify proper operation.

H. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

I. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 13
METERING

PART 1 – GENERAL

1.1 SECTION INCLUDES:

A. Unit's eight circuits shall perform to spec in harsh electrical applications in high and low voltage systems.

1. Unit shall support 3 element Wye, single phase 3-wire or 2-wire systems, and 2 CT Delta systems.

2. Voltage inputs shall be user programmable for voltage range to any PT ratio.

3. Voltage burden shall be .36 VA per phase Max at 600 volts and 0.014 VA at 120 volts.

4. Absolute voltage input range shall be up to 576 V L-N and 721 V L-L.

5. Current shall be programmable to any CT ratio.

6. Current burden shall be 0.005 VA per phase, Max at 11 A.

7. Current inputs for Class 10 shall be: 5 A Nominal CT with overrange to 10 A secondary.

8. Current inputs for Class shall be : 2 1 A Nominal CT with overrange to 2 A secondary.

B. Unit shall have accuracy of +/- 0.5% or better for voltage and current, and 0.5% for power and energy. Unit shall meet accuracy requirements of IEC 62053-22 (Class 0.5S) and ANSI C12.20 (Class 0.5 CL).

1. Unit shall provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.

2. Unit shall have 24-bit Analog to Digital converters.

C. Unit shall have multiple communication ports

1. Com 1 shall support RS485 and optional RJ45 Ethernet/802.11b WiFi. module. Ethernet module shall provide

a. Web configuration of Ethernet, WiFi, and serial port Modbus bridge.

b. Username and password security for configuration and ability to modify the username and password.

c. Optional Telnet configuration.

d. Up to 10 sockets each of RJ45 and WiFi Ethernet communication, simultaneously.

e. Module firmware update through the web configurator.

f. Web dashboard with display of module settings.

g. Factory reset of module through the web.

h. Ability to save module settings and upload them to a new module.

i. Timeout to free communication socket after six minutes of no response to Keep Alive message.

2. Com 2 shall be a USB serial port.

3. Com 3 shall support RS485 communication.

D. Unit shall have four KYZ pulse counting inputs and two relay control outputs.

1. Inputs shall be configurable to count pulses from gas, water, condensate, and other commodity measuring devices.

2. Outputs shall be available for control applications. Meter shall be configurable to trigger relay output on alarm condition. Up to eight limits shall be assignable.

E. Unit shall have optional datalogging memory of up to 32 MB. Datalogging shall support:

1. One fully configurable historical log and one pre-configured historical log for trending energy usage over time.

2. Alarm/Limits log.

3. System events log.

4. I/O change log that records changes in the unit's relay outputs/digital inputs.

5. V3 option* shall be capable of retaining interval energy data for three years.

F. Provide color LCD HMI touchscreen external display.

1. Display shall be 5.7".

2. Display shall support RS485 and RJ45 Ethernet, simultaneously.

3. Display shall be pre-configured to display readings, diagnostic data, limit/alarms, phasor diagram, and non-electrical measured parameters, e.g., water, gas.

G. Unit shall have upgrade packs that enable additional functionality without removing the unit from service.

H. Unit shall be programmable by software supplied by unit manufacturer. Unit's data shall integrate with energy usage analysis and billing module and with cloud-based energy management system for Enterprise-wide power quality and usage analysis, predicted usage and demand, reporting, and email alarms.

I. Unit shall have a 4-year warranty.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Wall dimmers.

C. Receptacles.

D. Wall plates.

E. Floor box service fittings.

1.2 RELATED REQUIREMENTS

A. Section 26 05 33.16 - Boxes for Electrical Systems.

B. Section 26 05 33.16 - Boxes for Electrical Systems

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for 2014h, with Amendments (2017).

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification) 2014g, with Amendment (2017).

C. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

D. NECA 130 - Standard for Installing and Maintaining Wiring Devices 2016.

E. NEMA WD 1 - General Color Requirements for Wiring Devices 1999 (Reaffirmed 2020).

F. NEMA WD 6 - Wiring Devices - Dimensional Specifications 2016.

G. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 20 - General-Use Snap Switches Current Edition, Including All Revisions.

I. UL 498 - Attachment Plugs and Receptacles Current Edition, Including All Revisions.

J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices Current Edition, Including All Revisions.

K. UL 943 - Ground-Fault Circuit-Interrupters Current Edition, Including All Revisions.

L. UL 1310 - Class 2 Power Units Current Edition, Including All Revisions.

M. UL 1449 - Standard for Surge Protective Devices Current Edition, Including All Revisions.

N. UL 1472 - Solid-State Dimming Controls Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.

2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.

3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.

4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.

5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.

6. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items except field quality related items and O/M documentation, in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1. Wall Dimmers: Include derating information for ganged multiple devices.

2. Surge Protection Receptacles: Include surge current rating, voltage protection rating (VPR) for each protection mode, and diagnostics information.

D. Samples: One for each type and color of device and wall plate specified.

E. Certificates for Surge Protection Receptacles: Manufacturer's documentation of listing for compliance with UL 1449.

F. Field Quality Control Test Reports.

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

H. Operation and Maintenance Data:

1. Wall Dimmers: Include information on operation and setting of presets.

2. GFCI Receptacles: Include information on status indicators.

3. Surge Protection Receptacles: Include information on status indicators.

I. Project Record Documents: Record actual installed locations of wiring devices.

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.

3. Extra Keys for Locking Switches: Two of each type.

4. Extra Surge Protection Receptacles: Two of each type.

5. Extra Wall Plates: One of each style, size, and finish.

6. Extra Flush Floor Service Fittings: Two of each type.

7. Extra Poke-Through Core Hole Closure Plugs: Two for each core size.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

D. Products: Listed, classified, and labeled as suitable for the purpose intended.

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

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

D. Provide GFCI protection for receptacles installed within 6 feet (1.8 m) of sinks.

E. Provide GFCI protection for receptacles installed in kitchens.

F. Provide GFCI protection for receptacles serving electric drinking fountains.

G. Unless noted otherwise, do not use combination switch/receptacle devices.

2.2 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices, Unless Otherwise Indicated: Ivory with ivory nylon wall plate.

2.3 WALL SWITCHES

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell.com/#sle.

2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.

3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.

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

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20and where applicable FS W-S-896; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

E. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

F. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

G. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.

H. Locking Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.4 WALL DIMMERS

A. Manufacturers:

1. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.

2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.

3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.

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

B. Wall Dimmers - General Requirements: 0-10 volt compatible with LED driver.

C. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.5 RECEPTACLES

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell.com/#sle.

2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.

3. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.

4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.

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

6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wall plates by the same manufacturer in locations indicated.

B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498and where applicable FS W-C-596; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.

2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles:

1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.

2. Automatically Controlled Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking on device face per NFPA 70; single or duplex as indicated on the drawings, split-wired controlled

3. Isolated Ground Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.

4. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

5. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.

6. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

D. GFCI Receptacles:

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

5. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

E. USB Charging Devices:

1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.

a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.

b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.

2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.

F. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.

1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.

G. Clock Hanger Receptacles: Single, 15A, 125V, NEMA 5-15R.

2.6 WALL PLATES

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell-wiring.com/#sle.

2. Leviton Manufacturing Company, Inc: www.leviton.com/#sle.

3. Lutron Electronics Company, Inc: www.lutron.com/#sle.

4. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us/#sle.

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

6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wall plates by the same manufacturer in locations indicated.

B. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.

2. Size: Standard.

3. Screws: Metal with slotted heads finished to match wall plate finish.

C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

2.7 FLOOR BOX SERVICE FITTINGS

A. Manufacturers:

1. Hubbell Incorporated: www.hubbell.com/#sle.

2. ABB/Steel City (formerly Thomas & Betts Corporation): www.ABB.com

3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.

4. FSR, Inc: https://fsrinc.com/

B. Selected manufacturer should offer complete family of complementary products which include each configuration shown on schedule as included in project scope.

C. Description: Service fittings compatible with floor boxes provided under Section 26 05 33.16 with components, adapters, and trims required for complete installation.

D. Flush Floor Service Fittings:

1. (Type F1A) Single Service Flush Convenience Receptacles: Fittings, conduit requirements and cover as indicated in schedule

a. Legrand/Wiremold Omni Series, or equal

2. (Type F1FF) Single Service Flush Furniture Feed: Fittings, conduit requirements and cover as indicated on schedule.

a. Legrand/Wiremold Omni Series, or equal

3. (Type F2A) Two Gang Multi Service Flush Combination Outlets: Fittings, conduit requirements and cover as indicated on schedule.

    a. Legrand/Wiremold RFB Series, or equal

4. (Type F2B) Four Gang Multi Service Flush Combination Outlets: Fittings, conduit requirements and cover as indicated on schedule

    a. Legrand/Wiremold Evolution Series, or equal

5. (Type F2C) Six Gang Multi-Service Flush Combination Outlets: Fittings and cover as indicated on schedule

    a. Legrand/Wiremold Evolution Series, or equal

6. (Type F2D) Eight Gang Multi Service Flush Combination Outlets: Fittings, conduit requirements and cover as indicated on schedule.

    a. Legrand/Wiremold Evolution Series, or equal

7. (Type F2E) Ten Gang Multi Service Flush Combination Outlets: Fittings, conduit requirements and cover as indicated on schedule.

    a. Legrand/Wiremold Evolution Series, or equal

8. (Type F2FF) Dual Service Flush Furniture Feed: Fittings, conduit requirements and cover as indicated on schedule

9. (Type F2G) Multi Service Convention Floor box:

    a. Cover: 32,000# rated cover

    b. Legrand/Wiremold CCFB Series

10. Accessories:

    a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.

    b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

    c. Fire Rated Pour Pans: As required to maintain floor rating

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that floor boxes are adjusted properly.

F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

G. Verify that core drilled holes for poke-through assemblies are in proper locations.

H. Verify that openings in access floor are in proper locations.

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

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.

1. Mounting Heights: As indicated on the drawings.

2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.

3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.

4. Locate wall switches on strike side of door with edge of wall plate 3 inches (80 mm) from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.

5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches (150 mm) long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

1. Do not utilize equipment grounding conductor as a current carrying conductor for electronic switching/dimming/sensor devices.

2. Include a grounded (neutral) conductor with switch leg.

H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.

I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

J. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.

K. Install wiring devices plumb and level with mounting yoke held rigidly in place.

L. Install wall switches with OFF position down.

M. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

N. Install in-line GFCI devices in flush enclosure, adjacent to and matching finish of the panelboards serving the associated circuit. Coordinate placement with equipment in the area to ensure proper working clearances are maintained.

O. Do not share neutral conductor on branch circuits utilizing wall dimmers.

P. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

Q. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

R. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

S. Identify wiring devices in accordance with Section 26 05 53.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

F. Inspect each surge protection receptacle to verify surge protection is active.

G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 28 16.13
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 05 73 - Power System Analysis.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service 2013e (Amended 2017).

B. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.

H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted enclosed circuit breakers where indicated.

4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items except field quality related items and O/M documentation, in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.

1. Include characteristic trip curves for each type and rating of circuit breaker upon request.

D. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

E. Field Quality Control Test Reports.

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

G. Project Record Documents: Record actual installed locations of enclosed circuit breakers.

H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C) during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ABB/GE: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

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

F. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED CIRCUIT BREAKERS

A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.

B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet (2,000 m).

2. Ambient Temperature: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

D. Short Circuit Current Rating:

1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

E. Conductor Terminations: Suitable for use with the conductors to be installed.

F. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

G. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

H. Provide externally operable handle with means for locking in the OFF position.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:

1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:

2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

C. Conductor Terminations:

1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

D. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.

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

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install enclosed circuit breakers plumb.

F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches (2000 mm) above the floor or working platform.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.

K. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

L. Identify enclosed circuit breakers in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance. Tests listed as optional are not required.

1. Perform insulation-resistance tests on all control wiring with respect to ground.

2. Test functions of the trip unit by means of secondary injection.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

E. Test GFCI circuit breakers to verify proper operation.

F. Test shunt trips to verify proper operation.

G. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 28 16.16
ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

B. Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 05 73 - Power System Analysis.

F. Section 26 28 13 - Fuses.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum) 2013.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems 2017.

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations Current Edition, Including All Revisions.

H. UL 98 - Enclosed and Dead-Front Switches Current Edition, Including All Revisions.

I. UL 869A - Reference Standard for Service Equipment Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.

2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.

4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items except field quality related items and O/M documentation, in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

D. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.

2. Include wiring diagrams showing all factory and field connections.

E. Field Quality Control Test Reports.

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

G. Project Record Documents: Record actual locations of enclosed switches.

H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. See Section 26 28 13 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

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

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C) during and after installation of enclosed switches.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ABB/GE: www.electrification.us.abb.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

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

F. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy or general duty as indicated; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet (2,000 m).

2. Ambient Temperature: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:

1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

2. Minimum Ratings:

a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.

b. General Duty Single Throw Switches Protected by Class R, Class J, or Class T Fuses: 100,000 rms symmetrical amperes.

c. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.

d. Double Throw Switches Protected by Class R, Class J, or Class T Fuses: 100,000 rms symmetrical amperes.

G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

H. Provide with switch blade contact position that is visible when the cover is open.

I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.

1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

J. Conductor Terminations: Suitable for use with the conductors to be installed.

K. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

L. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

M. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1.

b. Outdoor Locations: Type 3R.

2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

N. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

O. Heavy Duty Switches:

1. Comply with NEMA KS 1.

2. Conductor Terminations:

a. Provide mechanical lugs unless otherwise indicated.

b. Provide compression lugs where indicated.

c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

a. Provide means for locking handle in the ON position where indicated.

P. General Duty Switches:

1. Conductor Terminations:

a. Provide mechanical lugs.

b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

2. Provide externally operable handle with means for locking in the OFF position, capable of accepting two padlocks.

Q. Provide the following features and accessories where indicated or where required to complete installation:

1. Hubs: As required for environment type; sized to accept conduits to be installed.

2. Integral fuse pullers.

3. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.

4. Viewing Window: Positioned over switch blades for visual confirmation of contact position with door closed.

5. Interlocked Receptacle: Integral pre-wired three phase, three wire, grounded type receptacle interlocked with switch mechanism to prevent insertion or removal of plug with switch in the ON position and to prevent switch from being placed in the ON position without matching plug inserted. Provide receptacle configuration as required to accept plug as indicated on the drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

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

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Provide required seismic controls in accordance with Section 26 05 48.

F. Install enclosed switches plumb.

G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches (2000 mm) above the floor or working platform.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Identify enclosed switches in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 29 23
VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. For motors as scheduled on the drawings with variable frequency drives, provide variable frequency motor controllers as specified herein.

B. Provide Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. Drive manufacturer shall have the following support organizational structure:

1. Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.

2. An independent service organization that is factory trained and certified to start, test and diagnose the VFD provided

C. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.

1.2 RELATED REQUIREMENTS

A. Section 23 05 00 - Common Work Results for HVAC

B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment

C. Section 23 09 25 - Building Automation and DDC Control System

1.3 REFERENCE STANDARDS

A. IEEE Standard 519-2014 - IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

B. UL 508C or UL 61800-5-1 - Standard for Power Conversion

C. NEMA ICS 7.0-2006 - AC Adjustable Speed Drives

D. NEMA ICS 7.1-2006 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems

E. IEC 16800-5-1 Parts 1 and 2: Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy.

1.4 SUBMITTALS

A. Submittals shall include the following information. Submit all items in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

1. Outline dimensions, conduit entry locations and weight.

2. Customer connection and power wiring diagrams.

3. Complete technical product description - include a complete list of options provided.

1.5 QUALIFICATIONS

A. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.

B. CE Mark - The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

1.6 WARRANTY

A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ABB ACH Series.

B. Danfoss, VLT.

C. Yaskawa.

2.2 ADJUSTABLE FREQUENCY DRIVES

A. VFD package as specified herein shall be enclosed in a UL Listed Type 1 or 3R enclosure unless otherwise indicated, completely assembled and tested by the manufacturer in an ISO9001 facility.

B. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, -35% nominal voltage as a minimum.

C. Environmental operating conditions: 0 to 40 degree C (32 to 104 degree F) continuous.

1. VFDs that can operate at 40C intermittently (during a 24 hour period) are not acceptable and must be oversized.

D. Altitude: 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.

E. Provide VFDs with the following standard features:

1. The same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

2. Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.

3. Built-in time clock in the VFD keypad. The clock shall have a battery backup with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. Include a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame and provide four (4) separate, independent timer functions that have both weekday and weekend settings.

4. VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.

5. Cooling fans, designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.

6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

7. Ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.

8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.

9. Fixed impedance added in order to reduce the harmonics to the power line as well as add protection from AC line transients shall consist of either dual (positive and negative DC bus) DC bus reactors, or AC line reactors.

    a. Reactors shall provide rated impedance from 100% full load down to 50% full load.

    b. Reactors providing rated impedance only at 100% full load are not acceptable.

    c. VFDs with only one DC bus reactor shall add an AC line reactor.

10. Include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

11. Provide capability of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.

12. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.

13. Programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

14. For motors indicated on drawings, provide an integral bypass contactor for operation of motor at constant speed, electrically independent of the inverter. Include motor overload protection when in bypass mode. Include necessary control relays and switches to allow automatic controls and safeties to operate when drive is in bypass mode.

F. VFDs shall have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.

2. Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be variable from the VFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a

digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (i.e. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.

3. Two (2) programmable analog inputs shall accept current or voltage signals.

4. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.

5. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as follows:

   a. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications) the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.

6. Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.

7. Seven (7) programmable preset speeds.

8. Two independently adjustable accel and decel ramps with 1 - 1800 seconds adjustable time ramps.

9. Include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

10. Include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without derating the VFD or operating at high carrier frequency only at low speeds.

11. Include password protection against parameter changes.

G. Provide a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall utilize the following assistants:

1. Start-up assistants.

2. Parameter assistants

3. Maintenance assistant

4. Troubleshooting assistant

H. Applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

1. Output Frequency

2. Motor Speed (RPM, %, or Engineering units)

3. Motor Current

4. Calculated Motor Torque

5. Calculated Motor Power (kW)

6. DC Bus Voltage

7. Output Voltage

I. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

J. Serial Communications

1. The VFD shall have an RS-485 port as standard. The standard protocols shall be BACnet, Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.

2. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus - keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

3. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.

4. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

K. Provide integral EMI/RFI filters for all VFDs. The onboard filters shall allow the VFD assemble to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

L. All VFD's through 50HP shall be protected from input and output power miswiring. The VFD shall sense this condition and display an alarm on the keypad.

M. Features specified herein and noted on drawings shall be furnished and mounted by the drive manufacturer. All Features specified shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

N. Provide factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection and shall be provided in both drive and bypass modes.

O. Door inter-locked, padlock capable circuit breaker that will disconnect all input power from the drive and all internally mounted options.

P. Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD - fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability.

1. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted.

2. Three contactor bypass schemes and designs will be not accepted.

Q. Provide single-phase motor protection.

1. Single phase motor protection shall protection drive in bypass mode.

R. The following operators shall be provided:

1. Bypass Hand-Off-Auto

2. Drive mode selector

3. Bypass mode selector

4. Bypass fault reset

S. The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.

1. Power-on (Ready)

2. Run enable (safeties) open

3. Drive mode select damper opening

4. Bypass mode selected

5. Drive running

6. Bypass running

7. Drive fault

8. Bypass fault

9. Bypass H-O-A mode

10. Automatic transfer to bypass selected

11. Safety open

12. Damper opening

13. Damper end-switch made

T. The following relay (form C) outputs from the bypass shall be provided:

1. System started
2. System running
3. Bypass override enabled
4. Drive fault
5. Bypass fault (motor overload or underload (broken belt))
6. Bypass H-O-A position

U. The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.

V. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman's Override 2). The remote start/stop contact shall operate in VFD and bypass modes.

W. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required.

1. One mode forces the motor to bypass operation and overrides both the VFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
2. The second fireman's override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).

X. The VFD shall include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

Y. Class 20 or 30 (selectable) electronic motor overload protection shall be included. There shall be an internal switch to select manual or automatic bypass.

Z. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install drives under this Division in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

B. Provide power wiring under Division 26. Wire and terminate connections in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

C. Coordinate control interface and wiring with Building Automation supplier.

3.2 START-UP

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.3 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.

3.4 TRAINING

A. Training of the Owner’s operation and maintenance personnel is required in cooperation with the Owner and the Construction Management Team. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled with the Owner after submission and approval of formal training agendas.

END OF SECTION

SECTION 26 33 23
CENTRAL BATTERY EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Fast-transfer interruptible power supply (IPS) centralized emergency lighting inverters.

1.2 REFERENCE STANDARDS

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit all items except field quality related items and O/M documentation, in a single, comprehensive package for review. Individual submissions for each line item will not be accepted.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

D. Shop Drawings: Indicate dimensions, input/output voltages, power ratings, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, and installed features and accessories.

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

F. Manufacturer's certification that products meet or exceed specified requirements.

G. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to inverter system components, enclosure, and finish.

D. Do not exceed maximum ambient temperature requirements for batteries at any time, which reduces battery service life. Replace batteries exposed to temperatures in excess of manufacturer's requirements.

1.6 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

PART 2 PRODUCTS

2.1 CENTRALIZED EMERGENCY LIGHTING INVERTERS - GENERAL REQUIREMENTS

A. Provide complete centralized emergency lighting inverter system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Inverter Assemblies: Manufactured units consisting of inverters, batteries, enclosures, and associated components specifically designed for emergency lighting applications; microprocessor-based utilizing pulse width modulation (PWM) with insulated gate bipolar transistors (IGBT's); listed and labeled as complying with UL 924.

1. Battery Run Times of 90 Minutes: Listed as complying with UL 924 for "emergency lighting and power equipment".

D. Provide inverters and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Increase indicated power ratings as required to accommodate any applicable inverter load restrictions.

F. Inverters Supplied by Engine Generators: Compatible with generator set to be installed in accordance with Section 26 32 13; include consideration of slew rate for proper synchronization.

G. Battery System:

1. Provide battery capacity as required for achieving battery run time indicated.

2. Battery Charger: Microprocessor-controlled, temperature compensated; capable of returning supplied battery(s) from fully discharged to fully charged condition within time required by NFPA 111 and UL 924 unless otherwise indicated.

3. Provide automatic low voltage battery disconnect to prevent battery "deep discharge" damage.

4. Battery Monitor: As specified under Section 25 36 23.

H. Enclosures:

1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

a. Indoor Clean, Dry Locations: Type 1 or Type 12.

I. Short Circuit Current Rating: Provide inverter assemblies with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.

J. Surge Tolerance: Capable of withstanding characteristic surges according to IEEE C62.41.2, location category B.

K. Automatic Sequence of Operations:

1. Upon failure or degradation of primary/normal input power, transfer load to battery power.

2. When primary/normal input power has been restored, retransfer load to primary/normal power and recharge battery.

L. Input Tolerance:

1. Voltage Range: Plus 10/minus 15 percent of nominal.

2. Frequency Range: Plus/minus 2.5 percent of nominal.

3. Total Harmonic Distortion (THD): 3 percent maximum at full load.

M. Output Requirements:

1. Voltage Regulation: Plus/minus 3 percent.

2. Frequency Range: Plus/minus 0.5 Hz.

3. Total Harmonic Distortion (THD): 3 percent maximum for linear load.

4. Load Power Factor Capability: From 0.8 lagging to 0.8 leading.

N. Features (Units Less than 500 VA):

1. Control Functions:

a. Automatic mode.

b. Manual Test Mode: Simulates failure of primary/normal source.

c. Self-testing/self-diagnostics.

2. Status Indications:

   a. Connected to primary/normal source.

   b. Primary/normal source available.

   c. Battery charging.

3. Alarm Indications (Units with Self-Testing/Self-Diagnostics):

   a. General trouble/alarm.

O. Features (Units 500 VA and Larger):

1. Control Functions:

   a. Automatic mode.

   b. Manual Test Mode: Simulates failure of primary/normal source.

   c. Automatic Bypass Mode (UPS Inverters Only): Upon applicable inverter circuit trouble/fault static transfer switch removes inverter from circuit and delivers power directly from primary/normal source (when available) to load.

   d. Automatic Shutdown Mode (IPS Inverters Only): Upon applicable inverter circuit trouble/fault unit shuts down.

   e. Manual Bypass Mode: Manual bypass switch removes unit from circuit and delivers power directly from primary/normal source to load for unit maintenance purposes.

   f. Self-testing/self-diagnostics.

2. Status Indications:

   a. Connected to primary/normal source.

   b. Connected to battery power.

   c. Primary/normal source available.

   d. Battery charging.

   e. Unit in manual bypass mode.

3. Measured Parameter Indications:

   a. Battery voltage.

   b. Output voltage (Volts AC); line-to-line and line-to-neutral; per phase.

   c. Output Current (Amps); per phase.

d. Output Frequency (Hz).

e. Output real/active power (kW); per phase.

f. Output apparent power (kVA); per phase.

g. Power factor; per phase.

h. Temperature.

4. Alarm Indications:

a. Output overload/overcurrent.

b. High temperature.

c. Low battery.

d. Output circuit breaker open (supervised circuit breakers only).

5. Other Features:

a. Input circuit breaker.

b. Event log.

c. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.

d. Remote monitoring capability via Ethernet and web interface.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Install inverter assemblies plumb and level.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

END OF SECTION

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Comply with provisions of Section 26 05 00.

B. This Section includes transfer switches rated 600 V and less. Refer to drawings for quantity, rating and configuration of transfer switches. Configurations include the following:

1. Automatic transfer switches
2. 4-pole transfer switches
3. Closed or open transition switches

1.2 RELATED REQUIREMENTS

A. Section 26 05 53 - Identification for Electrical Systems

1.3 REGULATORY REQUIREMENTS

A. In accordance with International Building Code, manufacturer shall test or analyze the transfer switch components and its mounting system or anchorage and submit a certificate of compliance for review and acceptance by Engineer and by the building official. Qualification shall be by an actual test on a shake table, by three-dimensional shock tests, by an analytical method using dynamic characteristics and forces, by the use of experience data or by a more rigorous analysis providing for equivalent safety. Refer the IBC and ASCE 7-05 for complete requirements.

1.4 REFERENCE STANDARDS

A. The equipment and components in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. UL 1008: Underwriters Laboratories Standard for Automatic Transfer Switches
2. NFPA 70: National Electrical Code including use in Emergency and Standby Systems in accordance with Articles 517, 700, 701, 702
3. NFPA 101: Life Safety Code
4. NFPA 110: Standard for Emergency and Standby Power Systems
5. IEEE 241: I.E.E.E. Recommended Practice for Electrical Power Systems in Commercial Buildings
6. IEEE 446: I.E.E.E. Recommended Practice for Emergency and Standby Power Systems

1.5 SUBMITTALS

A. Submit the following.

1. Product data: Product data sheets for each switch including rated capacities, weights, operating characteristics, furnished specialties and accessories.

2. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

3. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources and load showing interlocking provisions for each combined transfer switch and bypass/isolation switch.

4. Features and operating sequences, both automatic and manual.

5. Manufacturer Seismic Qualification Certification: Submit certificate of compliance for seismic requirements per IBC and other sections of the Project Manual.

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

b. The term withstand means the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

c. Dimensioned Outline Drawings of Equipment: Identify center of gravity and locate and describe mounting and anchorage provisions.

d. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

6. Field quality-control test reports.

1.6 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.

1.7 OPERATION AND MAINTENANCE DATA

A. Provide minimum 8 copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division 01 and Division 26.

B. Submit operation and maintenance data based on factory and field testing, operation and maintenance of specified product. Include factory setting of relays, relay setting, and calibration instructions.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain transfer switches, annunciators and other equipment defined in this section through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.9 DELIVERY, STORAGE AND HANDLING

A. Transfer switches shall be provided with adequate lifting means and shall be able to be rolled or moved into installation position and bolted directly to floor without using floor sills.

B. Deliver, store, protect, and handle products in accordance with recommended practices listed in manufacturer's installation and maintenance manuals.

C. Inspect and report concealed damage to carrier within specified time.

D. Store in a clean, dry space. Maintain factory protection or cover with heavy-duty plastic, minimum 6 mil, to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.

E. Handle transfer switches in accordance with manufacturer's written instructions to avoid damaging equipment, installed devices, and finish. Lift only by installed lifting provisions.

1.10 PROJECT CONDITIONS (SITE ENVIRONMENTAL CONDITIONS)

A. Follow applicable NEMA, ANSI, and NECA standard practices before, during, and after installation.

B. Transfer switches shall be located in well-ventilated areas, free from excess humidity, dust, and dirt and away from hazardous materials. Ambient temperature of area will be between minus [30] and plus [40] degrees C. Indoor locations shall be protected to prevent moisture from entering enclosure.

1.11 SEQUENCING AND SCHEDULING

A. Provide a written detailed description of scheduled installation, testing, and startup dates.

1.12 WARRANTY

A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of delivery, whichever occurs first.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

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

1. Caterpillar

2. ASCO Power Technologies

3. ABB Company; General Electric Products

4. Onan/Cummins Power Generation

5. Russelectric, Inc.

6. Eaton

7. Kohler Co.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Switch Ratings: Refer to drawings for transfer switch types, voltage rating and current rating.

B. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

C. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

D. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid, electric-motor-operated mechanism, or electrically operated circuit breakers, mechanically and electrically interlocked in both directions.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double action; mechanically held in both directions.

2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225A and higher, shall have separate arcing contacts.

H. Neutral Switching: Where four-pole switches are indicated, provide fully rated neutral contact on same operating mechanism as phase contacts..

I. Neutral Terminal: Where three pole switches are indicated on the drawings, provide a solid and fully rated neutral, unless otherwise indicated.

J. Motor Loads: For switches that serve motor loads, furnish one the following (refer to drawings for preferred switch type):

1. Open transition transfer switch with in-phase monitor

K. Indicating Lights: All indicating lights on front of transfer switch to be LED type.

L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

M. Annunciation, Control, and Programming Interface Components: Provide communication capability with the generator paralleling switchgear for devices at transfer switches that communicate with remote programming devices, annunciators, or annunciator and control panels. Provide all switches with necessary accessories to provide a complete, integrated and functioning emergency paralleling power system.

N. Factory Wiring: Train and bundle factory wiring and label consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Electrical Identification."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

O. Enclosures: General-purpose NEMA 1 complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 MICROPROCESSOR CONTROLLER

A. Furnish a built-in microprocessor to provide sensing and logic for control of the switch with the ability to communicate serially through a serial communication module or Ethernet connectivity module.

B. Provide controller with 12 selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Provide true RMS voltage sensing, accurate to + 1% of nominal voltage and frequency sensing accurate to + 0.2%. Provide controller capable of operating over a temperature range of -20 to +60 degrees C. and storage from -55 to +85 degrees C.

C. Store default setup information and calibration data on nonvolatile EPROM.

D. Controller Display and Keypad: Provide a four-line, 20 character LCD display and 5 x 5, tactile keypad as an integral part of the controller for viewing all available data and setting desired operational parameters.

2.4 METERING

A. Provide a three phase digital ammeter with current transformers and shorting blocks. Sense current on the LOAD conductors.

B. Provide a three phase, digital voltmeter.

2.5 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-action type, incapable of pauses or intermediate position stops during normal functioning, except for delayed transition switches. Provide open, closed or delayed transition switches as indicated on drawings.

C. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pick at 90 percent and dropout at 85 percent.

2. In-Phase Monitor: Provide in-phase monitors on all automatic switches except for delayed transition switches, unless otherwise indicated on drawings. Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 10 electrical degrees, and only if transfer can be completed with 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

3. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

4. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup

at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

5. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Switch set to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

6. Test Switch: Simulate normal-source failure.

7. Switch-Position Pilot Lights: Indicate source to which load is connected.

8. Source-Available Indicating Lights: Supervise sources via transfer-switch normal-and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

9. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

10. Signal-Before-Transfer Contacts: Two sets of normally open/normally closed dry contacts, one that operates in advance of retransfer to normal source and one the operates in advance of transfer to emergency source in the test mode. Interval is adjustable from 1 to 30 seconds.

11. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

12. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

13. Load shed feature. Provide for a load shed input signal from the generator control system to allow for programmed load shedding.

14. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

15. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.

16. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

2.6 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 26 05 48 - Vibration & Seismic Controls For Electrical Systems

B. Identify components according to Section 26 05 53.

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Furnish and install all necessary interconnecting control and monitoring wiring between switches, generators, annunciators and elevator controllers as required for a complete operating system.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

c. Verify that manual transfer warnings are properly placed.

d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

b. Simulate loss of phase-to-ground voltage for each phase of normal source.

c. Verify time-delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires.

B. Emergency lighting units.

C. Drivers and power supplies.

D. Emergency power supply units.

E. Accessories.

1.2 SCOPE OF WORK

A. Furnish and install a lighting fixture of the type indicated by designator at each location shown on the drawings. All materials, accessories, components and any other equipment necessary for the complete and proper installation and operation of the lighting fixtures shall be furnished by the Contractor, including those not usually indicated on the drawings or specified, but that are necessary for the proper installation and operation of the fixtures.

B. Specifications and drawings are intended to convey the main features, function, and character of the fixtures only, and do not necessarily illustrate or set forth every item or detail necessary for completion of the work.

C. Where design intent is unclear in the documents, the Contractor shall contact the Architect in writing for clarification prior to proceeding with the item in question.

D. Where Contractor's BIM is used to produce, document, or otherwise coordinate the locations of lighting fixtures, it is the Contractor's responsibility to confirm that all lighting products to be provided for construction will fit into the intended locations.

1.3 RELATED REQUIREMENTS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems.

B. Section 26 05 33.16 - Boxes for Electrical Systems.

C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 09 23 - Lighting Control Devices.

E. Section 26 56 00 - Exterior Lighting.

1.4 REFERENCE STANDARDS

A. IES LM-63 - Approved Method: IES Standard File Format for the Electronic Transfer of Photometric Data and Related Information 2019.

B. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products 2019.

C. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules 2019.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

E. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems 2006.

F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems 2006.

G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices 2020.

H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility 2012 (Reaffirmed 2018).

I. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. NFPA 101 - Life Safety Code; Most recent edition adopted by Authority Having Jurisdiction, Including all applicable amendments and supplements.

K. UL 924 - Emergency Lighting and Power Equipment Current Edition, Including All Revisions.

L. UL 1598 - Luminaires Current Edition, Including All Revisions.

M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products Current Edition, Including All Revisions.

N. ASHRAE/IESNA Standard 90.1 - Energy Standard for Buildings (current version or most recent approved version by the local authority.)

O. IECC - International Energy Conservation Code (current version or most recent approved version by the local authority.)

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.

2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.

3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.

4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.6 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submittals shall be submitted for review for al lighting fixtures, lamps (as applicable), drivers/ballasts/power supplies (as applicable) in accordance with the requirements of the Contract Documents. Shop drawing submittals for multiple types must be submitted with a contents page listing each fixture by type designation with manufacturer, model number, lamp model number (as applicable), driver/ballast/power supply (as applicable.) Individual catalog cuts or drawings shall include complete fixture model numbers. Catalog cuts or drawings lacking sufficient detail to indicate compliance with Contract Documents will not be acceptable. The contents page, catalog cut sheets and custom shop drawings shall be arranged in alphanumeric order by fixture type designation. Submittals lacking organization may be rejected without review.

C. Review of shop drawings or samples does not waive contract requirements. Review of the shop drawings, submittals or samples does not relieve the Contractor from responsibility for deviations from the specifications or drawings, unless a letter is provided noting such deviations at the time of submission and received written acceptance for such deviations from the Architect and/or the Lighting Designer. Approval of shop drawings or samples does not relieve the Contractor from responsibility for errors in the shop drawings or samples. Contractor shall be fully responsible for lighting fixtures that are manufactured or installed without reviewed shop drawings and for fixtures not manufactured in accordance with the requirements of the Architect and/or the Lighting Designer shop drawing review to the extent that they may need to be removed and replaced entirely.

D. The design team reserves the right to make minor modifications to the specifications at the time of submittal review such that there is either no change in cost or any cost changes can be carried by a contingency or as otherwise acceptable to the Owner.

E. Preliminary lighting controls submittals shall be submitted simultaneously with lighting fixtures indicating compatibility between the fixture type control method, driver type, load, and control method.

F. The Contractor shall identify any long lead time or lighting fixture delivery issues that may adversely affect the project schedule, and immediately bring them to the attention of the Owner, Architect and/or Lighting Designer. The Contractor shall provide all products to the jobsite on time. Under no circumstances shall the Contractor delay the release of any

submittals to the design team for review and approval such that any delay would compromise the project schedule or instigate a need for a product substitution. Allow a minimum of 10 weeks for the delivery of standard products, and 20 weeks for custom products. Also, allow a minimum of 2 weeks for any subsequent submittal review by the design team and up to 3 weeks for the initial review of the complete lighting package.

G. Photometric Data:

1. Provide complete photometric data for lighting fixtures produced in accordance with methods of Illuminating Engineering Society of North America.

2. Upon request, provide illumination level calculation for typical areas or for areas where specialty fixtures are used.

H. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

2. Provide photometric calculations where luminaires are proposed for substitution upon request.

3. For architecturally integrated lighting fixtures, verify field dimensions and include them on shop drawings showing exact locations of fixtures. Where applicable, shop drawings shall include wiring diagrams, scale plans and details showing the method of installation of components, mounting hardware, secondary feeds, as well as a complete bill of materials. Changes to shop drawings by the manufacturer or Contractor are to be 'clouded' and dated prior to resubmission. No variation from the general arrangement and details indicated in the Contract Documents shall be made on the shop drawings, unless required to suit the actual conditions on the premises, and then only with the written acceptance of the Architect and/or Lighting Designer. All variations must be clearly marked as such on drawings submitted for review.

I. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:

a. Include estimated useful life, calculated based on IES LM-80 test data.

b. Include IES LM-79 test report upon request.

c. Include electrical characteristics: input voltage in volts, input current in amps, input power in watts.

d. Include data for total light output in lumens, luminaire efficacy in lumens per watt

e. Include power supply, thermal, optical and fixture losses.

2. LED Drivers: Include wiring diagram and list of compatible source units.

3. Lamps/source module: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.

4. Emergency Power Supply Unit: Include list of compatible lamp/source configurations and associated lumen output.

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

1. Field quality control reports

K. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.

2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.

M. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.7 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with a minimum of five years documented experience.

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

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.9 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide a minimum of five years of manufacturer warranty for LED luminaires, including drivers.

C. Provide five year pro-rata warranty for batteries for emergency lighting units.

D. Provide ten year pro-rata warranty for batteries for self-powered exit signs.

E. Provide five year full warranty for emergency power supply units.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

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

1. Bidders wishing to obtain approval on manufacturers other than those specified by name and catalog number series in LIGHTING FIXTURE SCHEDULE shall submit their requests no later than ten (10) business days before the bid opening. Acceptance will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved as equals to those specified per the requirements and scope of the project. If the bidders do not elect to obtain prior approval during the time so specified, the Owner has no obligation to review or consider any such article after the contract award.

2. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:

a. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.

b. Agrees to provide the same warranty for the substitution as for the specified product.

c. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.

d. Waives claims for additional costs or time extension that may subsequently become apparent.

3. Any substitutions inserted into a submittal package may be rejected on an individual basis or at the discretion of the design team, may invalidate the entire submittal. Any substitution may be rejected without review or consideration, at any time.

4. Under special circumstances, as authorized by the Owner, Architect, or Lighting Designer, substitution proposals may be requested from the Contractor for the purpose of cost reduction. Such proposals shall include individual unit prices for the specified products and for the proposed substitutions. Distributor and Contractor markup costs shall also be disclosed in the proposal. Any differences in installation costs for proposed substitutions shall also be provided.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, sources, drivers, power supplies, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.

2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.

3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

H. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.

2. Tested in accordance with IES LM-79 and IES LM-80.

3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

I. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.

1. LED Tape - General Requirements:

a. Listed.

b. Designed for field cutting in accordance with listing.

J. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.3 EMERGENCY LIGHTING UNITS

A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

C. Battery:

1. Size battery to supply all connected lamps, including emergency remote heads where indicated.

D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.4 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:

1. Provide ballasts containing no polychlorinated biphenyls (PCBs).

2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

3. Electronic Ballasts/Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

B. LED Drivers:

1. Manufacturer limitations: All LED drivers shall be supplied by the light fixture manufacturer and specifically paired with each light source so that the LED driver combination will operate per published performance, and is compatible with control

method indicated. Where possible, all fixture drivers shall be of the same family/series and shall be supplied by a single manufacturer.

2. General Requirements:

   a. Driver shall operate for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

   b. For some LED fixture, remote drivers are required. It is the contractor responsibility

   c. to properly size and otherwise 'engineer' the complete LED system to account for wire size, voltage drops, ambient conditions (dry/wet, temperature, dimmability, etc.) Each manufacturer should be contacted regarding confirmation of final installation details and arrangements. Contract documents may or may not indicate anticipated locations for remote drivers, but final locations will be subject to field conditions and are the responsibility of the contractor.

   d. Wherever available, provide dual voltage (120/277V) driver units.

   e. Integral thermal protection to automatically reduce power output to protect LED drive and LED light engine/fixture from damage due to over-temperature conditions that exceed the LED driver's maximum operating temperature at the calibration point.

   f. Drivers shall be designed and tested to withstand electrostatic discharges incurred during manufacturing, installation, or field troubleshooting without impairment of performance when tested according to IEC 61000-4-2.

   g. Drivers shall be designed and tested to withstand Category A surges of 4,000V according to IEEE C62.41.2 without impairment of performance.

   h. Drivers shall be Class A sound rating, inaudible in a 27 dBA ambient noise condition.

   i. Meet NEMA 410 inrush requirements for mitigating inrush currents with solid state lighting sources.

3. Dimming Range: Refer to LIGHTING FIXTURE SCHEDULE. Where dimming range is not indicated, request clarification from the architect prior to submitting bid. As a minimum, ten percent relative light output unless dimming capability to lower level is indicated, without flicker.

4. Control Compatibility: Fully compatible with the dimming controls to be installed.

5. Product(s):

a. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.

2.5 LED EMERGENCY POWER SUPPLY UNITS

A. Description: Self-contained LED emergency power supply units suitable for use with indicated luminaires, complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924, UL 1310 certified, and compliant with CEC Title 20 (California Energy Code)

B. Compatibility:

1. Drivers: Compatible with standard LED drivers operating 20-50V DC, or as indicated for associated fixture model.

C. Operation: Upon interruption of normal power source, solid-state control automatically switches connected fixtures to the LED emergency power supply for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

D. Universal input 120-277 VAC, 50/60 Hz

E. Diagnostics: Provide accessible and visible multi-chromatic combination test switch/indicator light to display charge, test, and diagnostic status and to manually activate emergency operation.

F. Operating Temperature: From 32 degrees F (0 degrees C) to 122 degrees F (50 degrees C) unless otherwise indicated or required for the installed location.

G. Five (5) Year Warranty

H. Accessories:

1. Provide compatible accessory remote combination test switch/indicator light where indicated.

2.6 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.

B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.

C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

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

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

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

D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

G. Suspended Ceiling Mounted Luminaires:

1. Do not use ceiling tiles to bear weight of luminaires.

2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.

3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.

4. Secure pendant-mounted luminaires to building structure.

5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.

6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.

7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

H. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.

2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.

3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

I. Suspended Luminaires:

1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.

2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.

3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet (1.2 m) between supports.

4. Install canopies tight to mounting surface.

5. Unless otherwise indicated, support pendants from swivel hangers.

J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

K. Install accessories furnished with each luminaire.

L. Bond products and metal accessories to branch circuit equipment grounding conductor.

M. Emergency Lighting Units:

1. Unless otherwise indicated, connect unit to unswitched power from circuit indicated. Bypass local switches, contactors, or other lighting controls.

N. Exit Signs:

1. Unless otherwise indicated, connect unit to unswitched power from circuit indicated. Bypass local switches, contactors, or other lighting controls.

O. Emergency Power Supply Units:

1. For field-installed units, install inside luminaire unless otherwise indicated. Where installation inside luminaire is not possible, install on top of luminaire.

2. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal ballast(s) in luminaire. Bypass local switches, contactors, or other lighting controls.

P. Identify luminaires connected to emergency power system in accordance with Section 26 05 53.

Q. Burn-In: Operate fixtures at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps/sources that fail prematurely due to improper lamp burn-in.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Test self-powered exit signs and emergency lighting units to verify proper operation upon loss of normal power supply.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.

C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.6 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.

3.8 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 27 05 00
COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Structured cabling Systems.

B. Cable management.

C. Security system - access control and closed-circuit television.

D. Emergency Responder Radio System (ERRS/First Responder DAS)

E. Integrated AudioVisual Systems for conference rooms

F. CATV/SATV Distribution System

1.2 RELATED REQUIREMENTS

A. Related Work Specified Under Other Divisions

1. Foundations and pads are required for equipment furnished under this Division.

2. Field painting, except such painting as is required to maintain shop coat painting and factory finish painting.

3. Flashing of conduits into roofing and outside walls.

4. Heating, ventilating, and air conditioning equipment.

5. Cutting and patching for low voltage systems Work, except for errors and omissions under this Division.

B. Related Work - Owner Furnished Equipment And System

1. CATV head-end electronics.

2. Voice and Data network electronics.

C. REFERENCE STANDARDS

1. The Contractor's performance of the work shall comply with applicable federal, state, and local laws, rules, and regulations. The Contractor shall give required notices, shall procure necessary governmental licenses, permits, and inspections, and shall pay without burden to Owner's Representative, all fees and charges in connection therewith unless specifically provided otherwise. In the event of a violation, the Contractor shall pay all fines and penalties, including attorney's fees and other defense costs and expenses in connection therewith.

2. Federal Communications Commission

   a. Equipment requiring FCC registration or approval shall have received such approval and shall be appropriately identified.

3. Codes, Standards, and Ordinances: Design, manufacture, test, and install telecommunications cabling networks per manufacturer's requirements and in accordance with NFPA-70 (National Electrical Code), state codes, local codes, requirements of authorities having jurisdiction, and particularly the following standards:

   a. ANSI/NECA/BICSI-568 -- Standard for Installing Commercial Building Telecommunications Cabling

   b. ANSI/TIA/EIA Standards

   c. ANSI/TIA/EIA-568-B.1 -- Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements

   d. ANSI/TIA/EIA-568-B.2 -- Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components

   e. ANSI/TIA/EIA-568-B.3 -- Optical Fiber Cabling Components Standard

   f. ANSI/TIA/EIA-569-A -- Commercial Building Standard for Telecommunications Pathways and Spaces

   g. ANSI/TIA/EIA-606(A) -- The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

   h. ANSI/TIA/EIA-607(A) -- Commercial Building Grounding and Bonding Requirements for Telecommunications

   i. ANSI/TIA/EIA-526-7 -- Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant

   j. ANSI/TIA/EIA-526-14A -- Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant

   k. ANSI/TIA/EIA-758(A) -- Customer-Owned Outside Plant Telecommunications Cabling Standard

   l. TIA/EIA TSB 67 - Transmission Performance Specifications for Field Testing of Twisted - Pair Cabling Systems.

   m. Install cabling in accordance with the most recent edition of BICSI(r) publications:

      1) BICSI -- Telecommunications Distribution Methods Manual

2) BICSI -- Cabling Installation Manual

3) BICSI -- LAN Design Manual

4) BICSI - Customer-Owned Outside Plant Design Manual

n. Federal, state, and local codes, rules, regulations, and ordinances governing the work, are as fully part of the specifications as if herein repeated or hereto attached. If the contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Owner's Representative in writing. Where the requirements of other sections of the specifications are more stringent than applicable codes, rules, regulations, and ordinances, the specifications shall apply.

1) American Society for Testing and Materials (ASTM): ASTM E. 814 - Fire Tests of Through - Penetration Firestops.

2) Underwriters Laboratories, Inc. (UL): U.L. 1479 - Fire Tests of Through - Penetrations Firestops.

3) Underwriters Laboratories, Inc. (UL): U.L. 1310 – Standard for Class 2 Power Units

4) Underwriters Laboratories, Inc. (UL): U.L. 60601-1 – Medical Electrical Equipment Safety

5) Underwriters Laboratories, Inc. (UL): U.L. 60950-1 – Information Technology Equipment Safety

6) Underwriters Laboratories, Inc. (UL): U.L. 1069 – Standards for Hospital Signaling and Nurse Call Equipment

7) Underwriters Laboratories, Inc. (UL): U.L. 2560 – Standard for Emergency Call Systems for Assisted Living and Independent Living Facilities

8) National Fire Protection Association (NFPA): NFPA 70 - National Electrical Code.

9) NFPA 75 – Standard for the Fire Protection of Information Technology Equipment

10) NFPA 76 – Standard for the Fire Protection of Telecommunications Facilities

11) Americans with Disabilities Accessibility Guidelines.

12) Code of Federal Regulations, Title 29, Chapter XVII, Part 1910 (OSHA).

13) International Building Code (IBC).

D. QUALITY ASSURANCE

1. Comply with applicable local, state, and federal codes.

2. Comply with applicable requirements of recognized industry associations that produce standards for the various trades.

3. Warrant work under this specification against faulty material or Workmanship in accordance with Division 01. If the project is occupied or the systems are placed in operation in several phases at the request of the Owner's Representative, then the warranty of each system or piece of equipment used shall begin on the date of substantial completion for each phase. The use of building equipment for temporary service and testing does not constitute the beginning of the warranty.

4. Equipment and material provided under this Division shall be periodically inspected and serviced by competent installers. This function becomes the responsibility of the Owner's Representative once the system is accepted by the Owner's Representative. The one-year material and Workmanship warranty is not intended to supersede normal inspection or service and shall not be construed to mean the Contractor shall provide free service for normal maintenance items such as periodic cleaning and adjustment due to normal use, nor to correct without charge, breakage, maladjustment, and other trouble caused by improper maintenance.

5. Upon completion of the contract and progressively as work proceeds, clean-up and remove dirt, debris, and scrap materials. Maintain the premises in a neat and clean condition at all times during construction. Protect and preserve access to head-end equipment at all times. Clean items with factory finishes. Touch-up minor damage to surfaces; refinish an entire piece of equipment when sustained major damage. All electronics must be protected from dust and other airborne debris.

E. COMPLETENESS OF WORK

1. The Contract Documents depict low voltage systems which are intended to be complete and functioning systems. All products, materials, labor, and programming necessary to render a fully functional system to fulfill the design intent shown on the documents shall be provided by the contractor.

2. Catalog numbers referenced throughout this Division's drawings and specifications are intended to convey a general understanding of the type of quality of the product required. Where written descriptions differ from information conveyed by a catalog number, the written description shall govern. No extra charge shall be allowed because a catalog number is found to be incomplete or obsolete.

F. SUBMITTALS

1. Comply with provisions of Division 01.

2. Submit shop drawings as called for in the Specification Sections that follow.

3. Within fifteen (15) days after the contract has been awarded, submit to the Designer for review a complete list of materials, equipment, and accessories proposed for use, listing the item and manufacturer's name only.

4. Based upon the aforementioned approved listing, the Contractor to submit complete brochures and shop drawings of all materials, fixtures, and equipment that he proposes to use giving the names of manufacturers, trade names and specific catalog numbers.

5. Individual functional systems including, but not limited to, structured cabling, nurse call, video surveillance, and access control, where applicable, are required to be submitted as complete packages, inclusive of all major material components. Submittal packages that are not inclusive of complete system components will be rejected.

6. Brochures to be submitted in time to allow fifteen (15) days from the date of receipt in the consultant's office before final approval or disapproval is required to meet the construction schedule. Submittal to bear Contractor's stamp of approval evidencing they have been examined and checked same and information contained therein is in accordance with contract requirements. Deviations must be clearly marked. "No Exception taken" response to shop drawings is not to be construed as permitting departure from the contractual documents.

7. The above-mentioned brochures are to be submitted and approved before any materials are ordered.

8. Proposed items must be clearly indicated when other items are shown on the same sheet. When proposing items other than those specified, brochures to contain both specified item sheets and proposed item sheets for ease of comparison. On request from the Designer, samples shall be submitted and/or set up, as directed, for inspection and approval. Samples will be returned to the Contractor.

9. Submittals with product pages not clearly identifying the proposed product will be rejected.

10. Shop Drawings: Submit specific shop drawings using computer drafting software and actual floor plans for major materials where called for or when requested by the Owner's Representative for the following:

    a. The dimensional layout of all communication rooms, drawn to scale, with equipment locations shown therein. Label walls with rating requirements to verify understanding of architectural documents. Clearances are to be in accordance with manufacturer and industry standards. Low voltage systems equipment submittals will be rejected without dimensioned room or equipment location layouts.

G. OPERATING AND MAINTENANCE MANUALS

1. Prior to final acceptance of the project, furnish to Owner's Representative complete bound sets of operation and maintenance manuals of instructions for operation and maintenance of all pieces of equipment and systems provided under this Division of specifications.

2. Manuals to also include all submittal data on all materials and equipment. Clearly indicate items provided on this project. Included a list giving name and address of nearest supply house which carry the spare parts and name and address and phone number of Installation Contractor to be given to Owner's Representative.

3. The supplier or manufacturer shall provide thorough training of all staff assigned to those areas receiving new systems and equipment. This training shall be developed and implemented to address two different types of staff. The end-users shall be trained on the features and functions of the systems, and the engineering or maintenance department will be trained on the routine maintenance and basic programming of the systems. All training shall take place on-site using the fully installed and certified system.

4. Three sets of the following data are required:

   a. Operating and maintenance instructions.

   b. Spare parts lists.

   c. Copies of approved submittal data.

   d. Warranty information including any required test results.

5. Arrange each set of data in an orderly way, and bind each set in a separate 3-ring, hard-cover binder.

6. At the completion of work, submit two complete sets of data to the Owner's Representative for distribution to the proper parties.

H. DELIVERY AND STORAGE

1. Insofar as possible, deliver items in manufacturers' original unopened packaging. Where this is not practical, cover items with protective materials, to keep them from being damaged. Use care in loading, transporting, unloading, and storage to keep items from being damaged.

2. Store items in a clean dry place and protect them from damage.

I. RECORD DRAWINGS

1. Keep a set of prints at the job site exclusively for recording deviations from the construction drawings.

2. Record locations and depths of buried and concealed conduits from fixed, easily identifiable objects, such as building walls. Where conduits are concealed in walls, indicate distances off of building corners or other building features not likely to be disturbed by future alterations.

3. Mark deviations in colored pencils so that the work of various systems can be easily identified.

4. When work is completed, record all deviations in an electronic format using AutoCAD in a format usable to the Owner's Representative. Coordinate this format with the Owner's Representative.

5. Submit two copies of completed "record drawings" on compact disc to the Owner's Representative for distribution.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All materials and equipment used in carrying out these specifications are to be new and have UL listing, or listing by other recognized testing laboratories when such listings are available. Specifications and drawings indicate name, type, and catalog numbers of materials and equipment to be used as "standards" shall not be construed as limiting competition. The contractor may, at his option, use materials, and equipment when, in the judgment of the Owner's Representative, they are equivalent to that specified. Prior approval of substitutions must be given prior to submittals.

PART 3 - EXECUTION

3.1 COORDINATION

A. Insofar as it is possible to determine in advance, advise the other trades to leave proper chases and openings. Place all outlets, anchors, sleeves, and supports prior to pouring concrete or installation of masonry work. Should the contractor neglect doing this, any cutting and/or patching required is to be done at this contractor's expense.

B. Visit the site and be informed of conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain the necessary information to completely estimate and perform the work involved.

C. Coordinate with other Divisions to ensure proper power requirements, grounding, fireproofing, and interlocking controls between the fire alarm system, egress doors, nurse call system, and Owner furnished systems, where applicable.

D. Notify other tradesmen of any deviations or special conditions necessary for the installation of work. Interferences between the work of various contractors are to be resolved prior to installation. Work installed not in compliance with specifications and drawings and without properly checking and coordinating as specified above shall, if necessary, be removed and properly reinstalled without additional cost to the Owner's Representative.

E. Coordinate with local telephone and cable service providers to assure that proper points of service, demarcation location, and grounding requirements are in accordance with contract drawings. Duct bank is to be provided by Division 26. This contractor shall be involved in discussions about services to the building.

1. Coordinate with other trades to provide wall and ceiling access panels wherever required for access to communication equipment.

F. Intent:

1. These sections of specifications and drawings form a complete set of documents for the communication systems for this project. Neither is complete without the other. Any item mentioned in one shall be as binding as though mentioned in both.

2. The intent of these specifications and drawings is to form a guide for the installation of a complete system. Where an item is reasonably necessary for a complete system but not specifically mentioned, such as conduit sleeves, pull boxes, fittings, expansion fittings, support hangers, etc., provide same without additional cost to Owner's Representative.

3. Telecommunications Room (TR) layouts indicted on drawings are diagrammatical only. The exact location of outlets and equipment is to be coordinated and governed by project conditions. The Designer reserves the right to make any reasonable changes (approximately 6 feet) in the location of junction boxes, or equipment prior to roughing in of such without additional cost to the Owner's Representative.

G. Deviations:

1. No deviations from specifications and drawings are to be made without the full knowledge and consent of the Designer.

2. Should Contractor find during the progress of work that existing conditions make desirable a modification of the requirements of any particular item, report such item promptly to Designer for his decision and instructions.

H. Main Horizontal Pathway/Raceway

1. Unless otherwise noted on the drawings, all communications/low voltage systems cabling shall be routed above accessible corridor ceilings via cable tray or j-hook supports. Cabling shall be segregated by function as follows:

a. Voice/data cabling

b. CATV cabling

c. Nurse call cabling

d. Security

e. All other systems as defined by the Owner/designer

f. Paging

3.2 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

A. Under other Divisions, provide trenching, excavation, and backfilling. Coordinate all requirements with trades. Failure to properly coordinate this effort resulting in additional trenching, excavation, backfilling, or repairs shall be performed without additional cost to the Owner.

3.3 PLYWOOD BACKBOARD AND WALL BACKING

A. As directed by the responsibility matrix, provide 4' W x 8' H x 3/4" D fire retardant A/C grade plywood backboard as indicated in all Communication Rooms. Plywood is to be installed 6" above the finished floor and painted with two coats of fire retardant paint.

B. Under other Divisions, provide appropriate backing in walls as required for mounting brackets and other wall-mounted equipment per manufacturer requirements.

3.4 FIRESTOPPING

A. Select an appropriate type or types of through penetration firestop devices or systems appropriate for each type of communications penetration and base each selection on criteria specified herein.

B. Selected systems shall not be less than the hourly time delay ratings indicated in the Contract Documents for each respective fire-rated floor, wall, or other partition of building construction. Firestop for each type of communications penetration shall conform to requirements of an independent testing laboratory design drawing or manufacturer's approved modification when used in conjunction with details shown on the Drawings.

C. Perform all necessary coordination with trades constructing floors, walls, or other partitions of building construction with respect to size and shape of each opening to be constructed and device or system approved for use in each instance.

D. Coordinate each firestop selection with adjacent work for dimensional or other interference and for feasibility. In areas accessible to the public and other "finished" areas, firestop systems work shall be selected, installed, and finished to the quality of adjacent surfaces of building construction being penetrated.

E. Use materials that have no irritating or objectionable odors when fire-stopping is required in existing buildings and areas that are occupied.

F. Provide damming materials, plates, wires, restricting collars, and devices necessary for proper installation of fire-stopping. Remove combustible installation aids after fire-stopping material has cured.

G. All firestops shall be installed in accordance with the manufacturer's instructions in order to maintain the specific rating assigned by the independent testing laboratory.

H. Existing raceways, cable trays, and cabling that penetrate existing building construction shall be fire stopped to the extent necessary to fill cavities that may exist between existing building construction and existing communications penetrations or existing conduit sleeve, and between existing conduits and existing conduit sleeve.

I. If required by inspecting authorities:

1. Expose and remove fire-stopping to the extent directed by inspecting authority to permit his or her inspection.

2. Reinstall new fire-stopping and restore Work where removed for inspection.

3.5 TESTS

A. Where such systems have been installed or modified by the contractor, and prior to final observation and acceptance, test and leave in satisfactory operating condition, such systems and equipment including, but not limited to the following:

1. Structured Cable System

2. Grounding.

3. Firestopping of all sleeves and conduits.

4. Access control and security camera system.

5. Telephone and LAN systems.

6. CATV/MATV distribution systems.

3.6 INSPECTION FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for communication systems installation.

B. In states where required by the department of health, the nurse call installer/manufacturer representative is required to attend the health department final inspections to assist in the demonstration and testing of the nurse call system.

3.7 OBSERVATIONS

A. When field observation services are a part of the project scope, the Designer will provide periodic observation of the progress of work specified herein. The purpose of the observation is to ensure compliance with the Contractor's work with specifications and drawings. The Designer may also observe tests required of this Contractor as called for in other sections of specifications.

B. Specifications and drawings represent work to be done in view of total project requirements. The final location of conduits, jacks, outlets, components, etc., to eliminate possible conflict with other trades is the responsibility of this Contractor. Contractor to provide all supervision required for his personnel to ensure that installation is made in accordance with specifications and drawings and all safety rules and regulations are observed. In event of conflicts of work on a project with other trades, the Contractor is to make every reasonable effort to resolve conflict through meetings and discussions with other parties involved, by preparation of drawings or other appropriate action. Only after this has been done shall Designer assistance be requested through the RFI process.

C. When Designer is requested to visit the project to aid in the resolution of conflicts, or for witnessing tests, they shall be given a minimum of 48 hours notice prior to the time their presence is requested at the job site.

3.8 WARRANTY-GUARANTEE

A. The Designer reserves the right to reject any part of the installation which does not successfully meet requirements as set out in these specifications.

B. This Contractor shall, and hereby does, guarantee all work installed under this Division shall be free from defects in workmanship and materials for a minimum period of one year from the date of final acceptance. Additional warranty provisions may be outlined in specific sections. The above parties further agree that they will repair and replace any defective material or workmanship which becomes defective within the terms of this warranty guarantee.

END OF SECTION

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Section 270500 - Common Work Results for Communications.

1.2 REFERENCES

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. Soares Book on Grounding, 13 Edition, 2017

C. TIA/EIA 568B

D. BICSI TDMM, latest edition

E. ANSI -J-STD 607C / EIA/TIA 607C

1.3 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittals procedures.

B. Product Data: Manufacturer's descriptive literature for each system component specified in this section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Buss Bars:

1. Manufacturers:

a. Harger BICSI pattern TMGB kit (#TGBI14420TMGBKT), or individual components.

b. Harger BICSI pattern TGB kit (#TGBI14220TGBKT), or individual components.

c. Chatsworth BICSI & ANSI/TIA/EIA Grounding Buss Bars, 20" TMGB (40153-020).

d. Chatsworth BICSI & ANSI/TIA/EIA Grounding Buss Bars, 12" TGB (13622-012) for small network rooms.

e. Ensure that all ground bus bars are sized to meet minimum EIA/TIA 607 grounding requirements for all equipment in space.

2. Rack-mount Buss Bar

a. Ortronics Grounding Strip (OR-808004551)

b. Chatsworth Horizontal Rack Buss Bar, 19" (10610-019)

3. Conductors

a. Bare copper conductor, stranded

b. Insulated copper conductor, insulated, green, stranded, or solid

B. Exothermic Weld Materials:

1. Manufacturers:

a. Erico; Cadweld products

b. Continental Industries; Thermoweld products

C. Connectors:

1. two-lug connectors, UL-listed, irreversible compression

2. single-lug connectors, UL-listed, irreversible compression

3. exothermic weld connectors, UL-listed

D. Stand-off Insulators:

1. Harger

2. Chatsworth

E. Other materials as needed to form a complete grounding system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Telecommunications Ground Busbar (TGB):

1. Contractors shall position the TGB such that it is protected from physical damage from moving equipment, foot traffic, floor cleaning, etc. Contractors shall install the TGB with stand-off insulators.

2. The electrical ground conductor shall be extended from an electrical panel ground and connected to the TGB by the Division 26 contractor in accordance with Division 26 specifications.

3. The Contractor shall prepare all painted or non-conductive surfaces as necessary to achieve a sufficient bond. Star washers may be used to penetrate painted surfaces if a sufficient bond can be achieved.

4. The Contractor shall provide and install all necessary grounding hardware to properly ground the equipment in the network room per codes, standards, methodologies, and specifications listed in this document. Self-tapping screws, or any other type of screws, shall not be used to form bonds or attach grounding hardware.

5. Within each network room, the Contractor shall provide and install an insulated (green), stranded #6 copper ground wire from a network room TGB to each of any:

   a. Racks

   b. Ladder rack

   c. Electrical surge protection

   d. Shielded cable sheaths

6. The Contractor shall not bend the grounding conductor wires into tight angles. Changes in direction shall be of the highest radius possible.

B. Large Telecommunications Enclosures Installations:

1. The Contractor shall install a grounding Buss Bar in any enclosure housing networking or other active equipment. The Contractor may install the Buss Bar at any accessible and reasonable location. The Buss Bar may be a rack-mount Buss Bar attached to rails or a backboard.

2. The Contractor shall prepare all painted or non-conductive surfaces as necessary to achieve a sufficient bond. Star washes may be used to penetrate painted surfaces if a sufficient bond can be achieved.

3. The Contractor shall provide and install all necessary grounding hardware to properly ground the equipment in the network room per codes, standards, methodologies, and specifications listed in this document. Self-tapping screws, or any other type of screws, shall not be used to form bonds or attach grounding hardware.

4. The Contractor shall connect the enclosure to a TBB with no more than 30 feet of insulated (green), stranded #6 copper ground wire.

5. The Contractor shall not bend the grounding conductor wires into tight angles. Changes in direction shall be of the highest radius possible.

3.2 TESTING:

A. The Contractor shall test the impedance of all bonds of the grounding system, including cable armor bonding to the ground. The impedance of a two-point bonding test across any bond shall not exceed 0.1 ohm. The Contractor shall remediate any bond(s) over this limit or which contribute to a total impedance exceeding 0.1 ohm from any point in the network room to the Buss Bar in that room.

B. All bonds installed by the contractor shall be tested for impedance with an earth-ground resistance test in its two-point setup, such as a LEM Handy GEO tester. Place a QA label (with the date and inspector) in proximity to each bond tested.

C. Test all grounding conductors, once installed, for current. Measure AC and bi-directional DC current. Report any AC current over 1 Amp. Report any DC current, in either direction, over 500 milliamps.

END OF SECTION

SECTION 27 05 28.29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cable supports.

B. Anchors and fasteners.

1.2 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.3 DEFINITIONS

A. Section 078400 – Firestopping

B. See Section 27 05 00 - Common Work Results For Communications

C. Section 270526 – Grounding and Bonding for Communications.

1.4 REFERENCE STANDARDS

A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association.

B. NFPA 70 - National Electrical Code; National Fire Protection Association.

C. See Section 01 42 19 - Reference Standards.

D. TIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog data for fastening systems.

C. Product Samples: As required

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Product: Listed and classified by Underwriters Laboratories, Inc. is suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. ERICO International Corporation

B. Arlington

C. Substitutions: Submit substitution request for approval prior to installation.

2.2 CABLE SLING

A. Provides proper support of Category 5e, Category 6, fiber optic and innerduct

B. Adjustable strap

C. cULus® Listed

D. Complies with NEC® and TIASM requirements for structured cabling systems

E. Suitable for air handling spaces (plenum)

F. Acceptable Manufacturers:

1. nVent Caddy

a. Part CAT 425

2. Substitutions: Submit substitution request for approval prior to installation.

2.3 CABLE LOOP

A. Flexible and non-metallic

B. UV rating when used outdoors

C. Loop Size:

1. 2" TL20: 2 inches

2. 2.5" TL25: 2-1/2 inches

3. 5" TL50: 5 inches

D. Color: White

E. Material: Plastic

F. Acceptable Manufacturer

1. Arlington

2. Substitutions: Submit substitution request for approval prior to installation.

2.4 OPEN-TOP CABLE SUPPORT (J-SUPPORT)

A. Prefabricated, zinc coated, carbon steel designed specifically for telecommunication cable installations.

B. Open top, 90 degree rolled edges and 1-5/8 to 4-inch minimum diameter loop as per load and growth requirements.

C. UL listed and spaced at 4 to 5-foot intervals.

D. Provide beam clamps, rod fasteners, flange clips, and brackets as job conditions require.

E. Acceptable Manufacturers:

1. Cooper B-Line

2. Erico

3. Panduit.

4. nVent Caddy

5. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.5 CABLE TIE

A. Plenum-rated when used in plenum environment. Hook and loop only.

B. Hook and loop type cable tie that easily reopens for moves, adds, and changes.

C. Acceptable Manufacturers:

1. Hubbell.

2. Leviton.

3. Ortronics.

4. Panduit.

5. Pass & Seymour.

6. Siemon.

7. Accepted Substitute in accordance with Section 012500 – Substitution Procedures~

2.6 ANCHORS AND FASTENERS:

A. Obtain permission from Architect before using powder-actuated anchors.

B. Concrete Structural Elements: Use precast inserts, expansion anchors, powder-actuated anchors, or preset inserts.

C. Steel Structural Elements: Use beam clamps, steel spring clips, steel ramset fasteners, or welded fasteners.

D. Concrete Surfaces: Use self-drilling anchors or expansion anchors.

E. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.

F. Solid Masonry Walls: Use expansion anchors or preset inserts.

G. Sheet Metal: Use sheet metal screws.

H. Wood Elements: Use wood screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall install cable supports above concealed ceilings using rigid support to a structural element or by attaching directly to a structural element.

B. Maintain the following clearances from possible sources of electromagnetic interference (EMI) exceeding 5 kVA:

1. Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway: 6 inches.

2. Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway: 12 inches.

3. Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways: 24 inches.

4. Electrical motors and transformers: 48 inches.

C. Install hangers and supports as required to adequately and securely support low voltage system components, in a neat and workmanlike manner, as specified in NECA 1.

1. Do not fasten the support to ceiling grid or ceiling grid supports, pipes, ducts, mechanical equipment, or conduit.

2. Obtain permission from Architect before drilling or cutting structural members.

D. The Contractor may install J-hook or sling-type supports by attaching with suspended ceiling grid-type with manufacturer clamps, provided:

1. The wire is painted orange prior to installation, to differentiate it from ceiling grid support wires.

2. The wire is not attached to the ceiling grid, as required by the NEC.

3. The wire is not used to support the ceiling grid, as required by the NEC, and

4. The local authority having jurisdiction understands they are not supports for the ceiling grid.

E. Supports shall be installed with a minimum clearance of six inches (6") above an acoustical drop ceiling and shall be placed in such a manner as to prevent cables from resting on any piping or mechanical systems.

F. Load supports as recommended by the manufacturer.

G. The Contractor shall support Category 5e cables with 5e designated J-hook type or sling-type supports in concealed ceiling spaces.

H. The Contractor shall support Category 6 cables with sling-type supports and not with J-hooks if supporting more than eight cables.

I. J-hook and sling-type supports must be installed every 4-5 feet at an irregular interval. Installation of supports at a repeating interval (i.e. every 4 feet exactly) may establish a standing wave induction of interference on the cable. Attaching support to alternating sides of structural steel can accomplish this as can a non-linear installation.

J. Support design shall allow for a visible sag in the cable. No cable shall be pulled tight.

K. Supports shall be sized at a minimum of 2-inch diameter. Limit number of 4-pair cables per bundle of fifty per support.

L. Separate different media types per support. Treat each type of media separately when determining support fill limits. Multiple tiers of support may be installed.

M. Use independent telecommunication-dedicated support rods, wires, and fasteners, no attachment to other systems acceptable.

N. Cable ties and other methods of binding cabling shall not be installed in such a fashion as to bend, crimp or deform the cabling in any way so as to alter the electrical or transmission characteristics of the cabling.

O. The Contractor shall "close" J-hook support with manufacturer-provided bars and not with cable ties. The Contractor shall not use cable ties to strap cable to J-hook supports. The Contractor shall not install cables under such strain as to require tying to supports.

P. Supporting Device

1. Provide steel angles, channels, and other materials necessary for proper support of wall-mounted cabinets, racks, panels, etc.

2. Cabinets, large pull boxes, and cable support boxes: Secure to ceiling and the floor slab and not from conduits.

3. Small equipment boxes may be supported on walls.

4. Racks for support of conduit and heavy equipment: Secure to building construction by substantial structural supports.

END OF SECTION

SECTION 27 05 28.36
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. Continuous, rigid, welded steel or stainless steel wire mesh cable management system.

B. Cable tray systems are defined to include but are not limited to, straight sections, supports, and accessories.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Sections, apply to this Section.

1.3 REFERENCES

A. References: IEC 61537 - Cable Tray Systems and Cable Ladder Systems for Cable Management

1. NEMA VE 1-2002/CSA C22.2 No. 126.1-02 - Metal Cable Tray Systems
2. ANSI/NFPA 70 (2005) - National Electrical Code (NEC)
3. TIA 569-A (1998) - Commercial Building Standard for Telecommunications Pathways & Spaces
4. ASTM A 510 - Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
5. ASTM A 380 - Specification for Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
6. ASTM B 633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
7. ASTM A 123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
8. ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
9. Norm NF/A 91-131 for Galvanized Steel
10. Norm NF/EN 12-329 for Electrozinc Coating
11. Norm NF/EN/ISO 14-61 for Hot-Dipped Galvanized Steel
12. Norm NF 10-088-2 for Stainless Steel

1.4 SUBMITTALS

A. Comply with requirements of Section 01330 Submittal Procedures.

B. Product Data: Submit manufacturer's product and datasheets for cable tray indicating dimensions, materials, and finishes, including UL Classification and NEMA/CSA Certification.

C. Shop Drawings: Submit shop drawings indicating materials, finish, dimensions, accessories, layout, supports, splices, and installation details.

D. Design Calculation: Verify loading capacities for supports.

E. Coordination Drawings: Include floor plans and sections drawings to scale. Include scaled cable tray layout and relationships between components and adjacent structural, mechanical, and other above systems elements. Data presented on these drawings shall be as accurate as preliminary surveys and planning can determine. Field verification of all dimensions, routing, etc., shall be required for correct installation to avoid conflicts with other above ceiling systems.

F. Factory-certified test reports of specified products, complying with IEC 61537, NEC, and NEMA VE a/CSA C22.2 No. 126.1.

G. Submit manufacturer's certification indicating compliance with ISO 9001.

H. Submit training procedure for certifying cable tray installers.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Approval and Labeling: Provide cable trays and accessories specified in this Section that are approved and labeled.

1. The Terms "Classified" pertaining to cable trays (rather than "Listed" and "Labeled": As defined in NFPA 70, Article 100).

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

C. Comply with NFPA 70, National Electrical Code, Article 392: Cable Trays; provide UL Classification and labels.

D. Comply with IEC 61537, Cable Tray Systems, and Cable Ladder Systems for Cable Management.

E. Comply with NEMA VE 1/CSA C22.2 No. 126.1 metal Cable Tray Systems, for materials, sizes, and configurations; provide cCSAus Certificate and labels.

1.6 COORDINATION

A. Coordinate layout and installation of cable tray with other systems installations.

1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect.

2. Storage and Handling: Avoid breakage, denting, and scoring finishes. Damaged products will not be installed. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY THE FOLLOWING:

A. Cablofil, Inc.,

B. Or approved equal.

2.2 MATERIALS AND FINISHES

A. Cable Tray Materials:

1. Galvanized Steel

B. Cable Tray Finishes:

1. Norm NF/A 91-131 for Galvanized Steel

C. Cable tray will consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous Safe-T-Edge T-welded top side wire to protect cable insulation and installers.

D. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.

1. Mesh: 2x4 inches (50 x 100 mm).

2. Straight Section Lengths: 118 inches (3,000 mm).

3. Wire Diameter: The patented design includes varying wire sizes to meet application load requirements; optimize tray strength, and allow the tray to remain lightweight.

4. Safe-T-Edge: Patented Safe-T-Edge technology on side wire to protect cable insulation and installers' hands.

5. Fittings: Wire mesh cable tray fittings are field-fabricated from straight tray sections, in accordance with the manufacturer's instructions and Item 2.3.

6. CF Series Cable Tray Size:

   a. Depth: Cable tray depth will be (unless otherwise shown on drawings)"

      1) 4 inches (105 mm)

   b. Width: Cable tray width will be (unless otherwise shown on drawings):

      1) 6 inches (150 mm)

      2) 18 inches (450 mm)

      3) 24 inches (600 mm)

   c. Length: Cable tray section length will be 118 inches (3000mm) unless otherwise shown on drawings.

   d. Fill Ratio: Cable tray may be filled to 40% of total allowed fill capacity. The cable tray shall be sized to accommodate future cabling changes or additions.

2.3 CABLE TRAY SUPPORTS AND ACCESSORIES

A. Fittings/Supports: Wire mesh cable tray fittings and field-fabricated from straight tray sections, in accordance with manufacturer's instructions. Supports will include the FAS (Fast Assembly System) where possible so that screws, bolts, and additional tools are not required for cable tray mounting; installation time is reduced, and tray path can adapt to installation obstacles without the need for additional parts. Place supports so that the support span does not exceed that shown on the drawings.

   1. Ceiling-mounted supports mount to ceiling structure directly or with 1/4", 3/8", or 1/2" threaded rod.

   2. Wall-mounted supports.

   3. Splices, including those approved for electrical continuity (bonding), as recommended by the cable tray manufacturer.

   4. Accessories: As required to protect, support, and install a cable tray system.

2.4 EQUIPMENT GROUNDING CONDUCTOR FUNCTION AND GROUNDING

A. UL Classified cable trays may act as Equipment Grounding Conductors. Contact Cablofil for approved sizes.

   1. Use UL Classified splicing methods as recommended by Cablofil.

      a. Ground cable trays at end of continuous run.

b. Ground continuous cable tray runs every 60 feet.

2. Cable trays that are not UL Classified will be grounded per NEC requirements and manufacturer recommendations.

a. Ground cable trays against fault current, noise, lightning, and electromagnetic interference by mounting grounding wire to each 10' cable tray section with grounding clamp, Cablofil Model GNDCL.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting the performance of cable trays. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cable tray level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

1. Cutting: Field-fabricate changes in direction and elevation by cutting and bending cable tray.

a. Cut cable tray wires in accordance with the manufacturer's instructions.

b. Cable tray wires must be cut with side-action bolt cutters with offset heads to ensure the integrity of protective finish layer.

c. Remove burrs and sharp edges from cable trays.

2. Certified Installers: Cable tray installers must have successfully completed Cablofil's Certified Installer program.

END OF SECTION

SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Label Communications Systems as detailed in this section.

1.2 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.3 REFERENCE STANDARDS

A. TIA/EIA 568B

B. BICSI TDMM latest edition

C. EIA 606

PART 2 - PRODUCTS

2.1 PRODUCT INFORMATION

A. All labels must be printed. Hand-written labels are not permitted.

PART 3 - EXECUTION

3.1 LABELING REQUIREMENTS

A. All horizontal cables shall be numbered at the jack and patch panel or 110-type termination hardware. Cables shall be identified with a self-adhesive label in accordance with TIA/EIA 606. At the jack, the label shall be placed on a section of the cable, behind the faceplate, that is accessible when the faceplate is removed. At the patch panel or 110-type terminating hardware, each cable should be clearly labeled at a location that can be viewed without removing bundle support ties.

B. Cables installed for wireless applications must be labeled on both ends to be in compliance with the National Electrical Code, Article 800.2 and 800.52(B).

C. The contractor shall submit a proposed labeling scheme with the initial submittal package. The labeling scheme must be coordinated with the Owner.

END OF SECTION

SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Section 27 11 23 - Communications Cabinets, Racks, Frames and Enclosures

B. Section 27 11 19 - Communications Termination Blocks and Patch Panels

1.2 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. TIA/EIA 568B

C. BICSI TDMM latest edition

PART 2 - PRODUCTS

2.1 PLYWOOD

A. 3/4" A/C-grade, void-free fire retardant plywood, painted as further specified.

2.2 PAINT

A. Intumescent:

1. ASTM E84(UL 723) "Surface burning characteristics of building materials" Class "A" rating.

2. ASTM E119(UL 263) "Fire tests of building construction and materials" certified.

a. Hy-Tech Flame Guard Additive for interior flat latex paint

b. PPG Pittsburgh Paint Firetex

c. Benjamin Moore 220 Latex Fire Retardant Coating

d. Sherwin Williams Flame Control

PART 3 - EXECUTION

3.1 INSTALLATION

A. Entrance Facilities:

1. OSP cables entering buildings shall adhere to NEC (2011) 800.50 (or its successor) requirements for conduit if OSP cables need to extend beyond 50 feet or one floor.

B. Network Rooms:

1. Network rooms shall be prepared with respect to power, entry pathways (cable tray, inter-floor sleeves, and building entrance conduits), plywood backboards, and other environmental conditions.

2. Service loops shall be secured to the wall in each location in an unobtrusive manner. Service loops shall not block access to other cables, utilities, or otherwise accessed structures (e.g. shut-off valves, meters, etc.). Service loops shall not rest horizontally on cable trays.

3. The plywood shall be anchored every two feet around the perimeter of the board only (no anchors greater than 6" from an edge) with galvanized or stainless steel anchors.

4. A/C-grade plywood shall be painted gray on both sides and all edges, twice, before mounting. At least one fire-retardant product information stamp per 4 x 8 sheet shall be left unpainted.

C. Pathways:

1. The Contractor shall install innerduct to protect unarmored optical fiber intra-building backbone cables.

2. Innerduct containing backbone cabling shall end with two feet of cable tray in network rooms. The innerduct may be shortened as needed to accommodate service loops.

3. Secure the innerducts to the wall of network rooms to prevent horizontal movement of the cable (D-rings are acceptable). Secure the cables to the wall in a non-deforming manner to prevent vertical movement of the cable. Plastic cable ties with screw-mounted (not adhesive-mounted) wall mounts are acceptable in this application.

4. The Contractor shall secure the innerduct to the back of the rack. The Contractor may secure the innerduct outside of the cable tray to facilitate bending the innerduct into the top of the rack. Metal or plastic cable ties with screw-mounted (not adhesive-mounted) wall mounts are acceptable in this application.

END OF SECTION

SECTION 27 11 19
COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Terminate communications horizontal cabling in communications rooms as identified on drawings and in specifications with the following components:

1. RJ-45 CAT6 and CAT6A modular patch panels
2. Optical fiber termination panels
3. Comply with all Division 26 specifications applicable to communications systems infrastructure and rough-in requirements.

1.2 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. TIA/EIA 568B

C. BICSI TDMM latest edition

PART 2 - PRODUCTS

2.1 PRODUCT INFORMATION

A. All communications material and equipment furnished shall be new, unused, and free of defects. The materials shall be clean and free of damage or corrosion and shall be of the best quality obtainable for the purpose intended.

B. All communications materials used shall be UL listed with a visible UL label when required by local codes.

2.2 ACCEPTABLE MANUFACTURERS

A. Belden

B. CommScope

C. Systimax

2.3 MODULAR PATCH PANELS

A. Horizontal Cable

1. Horizontal cable shall be terminated at the work area on T568B/A RJ-45 Information Outlets in a maximum six port configuration single gang faceplate (color), at the workstation. Dust cover/blank shall be installed as needed.

2. Refer to faceplate details in project drawings for proper jack layout.

3. Faceplate shall be (blank) in color.

4. In the Telecommunications Room (TR), terminate horizontal cable on 24 or 48 port modular patch panels.

5. Install Horizontal Cable Management for every 2 rows (48 ports) of modular terminations.

6. All UTP connecting hardware shall match the performance specifications as dictated by the installed cable to create a manufacturer-certified link.

7. Utilize 630A style wall plates with RJ-45 information outlets for wall telephones.

B. Horizontal Wireless LAN Cable

1. Horizontal cable shall be terminated above the ceiling on T568B/A RJ-45 Information Outlets in maximum two-port configuration surface mount boxes. Dust cover/blank shall be installed as needed.

2. Refer to faceplate details in project drawings for proper jack layout.

3. The surface mount box shall be Electrical Ivory in color.

4. In the Telecommunications Room (TR), terminate horizontal wireless LAN cable on 24 or 48 port modular patch panels.

5. Install Horizontal Cable Management for every 2 rows (48 ports) of modular terminations.

6. All UTP connecting hardware shall match the performance specifications as dictated by the installed cable to create a manufacturer-certified link.

2.4 OPTICAL FIBER PATCH PANELS

A. Optical Fiber Applications:

1. In the Telecommunications Rooms, optical fiber cables will be terminated in 2U Rack-mounted Patch Panels with a smoked Plexiglas cover.

2. Double density optical fiber adapter strips, loaded with 12 LC duplex adapters shall be used for single-mode rack terminations.

3. Double density optical fiber adapter strips, loaded with 12 LC duplex adapters shall be used for multimode rack terminations

PART 3 - EXECUTION

3.1 LABELING REQUIREMENTS

A. Refer to Section 27 05 53 - Identification For Communications Systems for labeling requirements.

END OF SECTION

SECTION 27 11 23
COMMUNICATIONS CABINETS, RACKS, FRAMES AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.2 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. TIA/EIA 568B

C. BICSI TDMM latest edition

D. TIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces

PART 2 - PRODUCTS

2.1 2 POST RACKS AND RACK ACCESSORIES:

A. Chatsworth Standard Rack 7' high 19" Black, part number 66353 - 703

B. Vertical cable management: Chatsworth CCS Combination Cabling Section, part number 30162-703

C. Approved equivalent

2.2 4 POST RACKS AND RACK ACCESSORIES:

A. Chatsworth Megaframe 7' high, 19" 30" deep, Black, part number M1032-70x

B. Approved equivalent

2.3 LADDER-TYPE CABLE TRAY

A. Chatsworth Universal Cable Runway, Black, 24", part number 10250-724, or approved equivalent, with associated couplings and supports, shall be installed in the communications rooms as indicated on the construction drawings. Utilize additional equivalent product widths as depicted on the construction drawings. All cable runways shall be securely fastened at all wall terminations on top of equipment racks.

B. Approved equivalent

2.4 RADIUS TYPE DROPS

A. Utilize cable tray radius type drops and rack radius drops compatible with tray and rack systems at all horizontal to the vertical tray to rack cable transitions for proper cable support.

2.5 HORIZONTAL CABLE MANAGEMENT

A. Install Horizontal Cable Management for every 2 rows (48 ports) of modular terminations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide and install an additional cable tray in the network room as shown on the drawings. The Contractor may adjust the cable tray size as appropriate for the total cables installed.

B. The Contractor shall provide and install hardware to maintain bend radii of cables at changes in direction of the cable tray.

C. The Contractor shall secure cable trays to permanent building structures.

D. The Contractor shall cover the bottom 1 foot of any cable tray all-thread support rods with conduit to prevent cable rub damage.

E. Coordinate exact placement with other trades.

F. Size supporting devices to withstand cable weight plus 60 percent future fill.

G. Cut and install per manufacturer's recommendations.

H. Bond and ground to TMGB/TGB with #6 Grounding Wire. Sections: Bolted together or tied together with Grounding Wire running the entire length of cable support system.

I. Maintain bend radius for fiber optic and copper cables when transitioning to/from the cable support system.

END OF SECTION

SECTION 27 13 23
OPTICAL FIBER INTRABUILDING BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.2 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. TIA/EIA 568B

C. BICSI TDMM latest edition

PART 2 - PRODUCTS

2.1 MATERIALS

A. The Contractor shall install the appropriate cable type, plenum or non-plenum, for the given environment. For a mixed environment, the contractor may install a plenum cable entirely to simplify the installation.

B. The cable may be single-mode/multimode hybrid cables where both fiber types are in a common outer sheath.General

C. Optical fiber cables shall meet or exceed all applicable national and local building fire code requirements. Fiber cables used in a return air plenum environment shall have an Underwriters Laboratories rating that meets or exceeds the requirements of NFPA 262-1985 and UL(r)-910. (OFNP/OFCP) and (UL(r)) shall be printed every two (2) feet on the cable jacket. The optical fiber riser cable shall have an Underwriters Laboratories rating that meets or exceeds the requirements of UL(r)-1666 (OFNR/OFCR) and (UL(r)) shall be printed every two (2) feet on the cable jacket. Riser cable exposed to return air plenum spaces in open cable tray shall be plenum rated.

D. Multi-mode, 50/125-micron OM4 grade, tight-buffered, armored, OFCR or OFCP rated

E. Single-mode, 8.3/125 micron OS2 grade, tight-buffered, armored, OFCR or OFCP rated

F. Manufacturers:

1. Corning
2. Systimax
3. Owner approved equivalent

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. At each end, the Contractor shall provide at least 10 feet of cable in a wall-mounted service loop just below the cable tray.

C. The Contractor shall secure the cable to the cable tray using Velcro cable ties.

D. The Contractor shall secure the cables to the wall to prevent horizontal movement of the cable (D-rings are acceptable). The Contractor shall secure the cables to the wall in a non-deforming manner to prevent vertical movement of the cable, preferably with a wire mesh grip.

E. The Contractor shall bond to ground both ends of all armored fiber cables

F. For any fiber installation between closets connected by 4" conduits, MaxCell will be installed in specified ducts as indicated on drawings. All conduits will be equipped with the appropriate MaxCell pathway devices (with pull strings) to maximize the fill ratio and utilization. MaxCell will be provided and installed by Division 27 contractor.

G. All-optical fiber cables are to be continuous and without splicing.

H. Comply with manufacturers' recommendations regarding pulling tension and allowable lubricants.

I. The Contractor shall be responsible for verifying actual footages and distances identified on attached prints.

J. The Contractor shall be responsible for verifying that conduits and raceways are ready for occupancy before cable placement.

K. The Contractor shall assume responsibility for difficulties or damage to the cable during placement.

L. Where fiber optic cable passes through vertical riser space or network rooms, secure fiber and/or innerduct to the wall vertically every 36 inches. Review fasteners, strain relief, and routing with the Construction Manager.

M. The Contractor shall test and label all cables. All optical fiber cables and pathways shall be clearly identified as housing optical fiber at intervals not greater than fifty feet.

END OF SECTION

SECTION 27 15 13
COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.2 DEFINITIONS

A. See Section 27 05 00 - Common Work Results For Communications

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. TIA/EIA 568B

C. BICSI TDMM latest edition

PART 2 - PRODUCTS

2.1 MATERIALS

A. Voice and data locations: Unshielded twisted pair, 4-pair Category 6, non-plenum rated. This cable shall be blue in color.

B. Wireless Access Point Locations: Unshielded twisted pair, 4 pair Category 6a, non-plenum rated. This cable shall be white in color.

C. Any UTP cable utilizing below-grade pathways shall be a filled or indoor/outdoor type cable, to prevent moisture intrusion, with the same performance characteristics and rating of other project UTP cables.

2.2 ACCEPTABLE MANUFACTURERS

A. Belden

B. CommScope

C. Systimax

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Replace UTP cables that do not pass test criteria for the appropriate level test.

C. Horizontal cables shall not exceed 90 m. The contractor is required to bring to the attention of the designer, prior to installation, any outlet locations within the project where distance may be a concern, due to unexpected installation conditions. The contractor must coordinate with the Division 26 contractor prior to cable installation to identify and optimize horizontal and vertical pathways, as well as sleeve requirements necessary to achieve this 90m goal. Installation to remote locations in excess of 90m may be allowed with pre-approval by the designer and Owner.

D. Copper Horizontal Cable Lengths:

1. Horizontal cables from the patch panel to the information outlet shall be no longer than 295ft. (90m).

2. Horizontal cables used for patch cords and cross-connect jumpers in the communications closet shall be no more than 16 ft (5m) long.

3. There is a 33ft (10m) allowance for the combined length of patch cords and cables used to connect equipment at the information outlet and communications closet.

4. The combined sum of all the above components shall be no longer than 328ft (100m).

E. Where copper cables route through vertical riser space or network rooms, secure bundles to the wall vertically every 24 inches. Review fasteners, strain relief, and routing with the Construction Manager.

F. The Contractor shall not untwist UTP cable pairs more than 0.5 inches when terminating.

G. The contractor shall make use of raceways built into furniture for open office furnished work areas, when conditions previously described are met.

H. The Contractor shall not install cable in common cable hangers with speaker cables.

I. The Contractor shall maintain the following clearances from EMI sources:

1. Power Cable: 6 inches.

2. Fluorescent Lights: 12 inches.

3. Transformers: 48 inches.

J. Do not install cable with more than 25 lbf (110 N) pull force, per ANSI/TIA/EIA and BICSI TDMM practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on; long pulls of multiple cables into a single small-bore conduit, on conduit runs greater than 100 linear feet with bends of opposing directions, and in conduit runs that exceed 180 degrees of accumulated bends. Use tensile-rated cords (i.e. fishing line) for difficult or questionable pulls - to judge to go/no-go condition of conduit and pulling setup.

K. The Contractor shall firestop all openings and penetrations through fire and smoke-rated wall and floor assemblies, based on classification of assembly.

END OF SECTION

SECTION 27 15 43
COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.2 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2011

B. TIA/EIA 568B

C. BICSI TDMM latest edition

PART 2 - PRODUCTS

2.1 MATERIALS

A. Faceplates:

1. Interface Plate, 6-port maximum, color to match electrical plate color
2. Utilize stainless steel plates in food service areas
3. Utilize weatherproof plates in outdoor applications.
4. Blank Insert, as needed

B. Surface mount wireless access point interface box.

1. Side entry surface mount box, 2-port, white in color

C. RJ45 Connector Modules:

1. Category 6 Modular Jacks, white for data designated jacks
2. Category 6a Modular Jacks, white for wireless access points

D. Fiber Optic Connectors

1. Single-mode connectors:
   a. LC connector, field installable, ceramic tip, average loss 0.2dB
   b. Consumables and fan out materials as required
2. Multimode connectors:
   a. LC connector, field installable, ceramic tip, average loss 0.1dB

b. Consumables and fan out materials as required

3. Fiber optic cable, connectors, and distribution panels shall be from a single manufacturer to ensure compatibility.

2.2 ACCEPTABLE MANUFACTURERS

A. Copper UTP Connecting Hardware:

1. Belden

2. CommScope

3. Systimax

B. Fiber Termination Hardware

1. Belden

2. Corning

3. CommScope

4. Systimax

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide 12" of cable slack in in-wall, surface-mounted, and raceway boxes, provided the manufacturer's bend radius is not exceeded. Some of the slack may be pulled back into junction boxes, raceways, cable trays, or concealed ceiling space. Slack beyond the outlet box shall be easily pulled out of the box and shall not be secured with cable ties or otherwise secured beyond the box to prevent this.

B. The Contractors shall install outlet modules as shown on the project drawings.

C. The Contractor shall terminate all RJ45 outlets in the T568B pin/pair configuration. All four pairs shall be terminated.

D. The Contractor shall provide and install blank modules in faceplates, as needed.

E. The Contractor shall cover all outlet openings with masking tape if another construction is taking place in the area. Tape shall be applied with sufficient pressure to ensure up to 60 days of adhesion. Tape shall not wrap around the edges of the faceplate or surface-mount box.

F. The Contractor shall install all outlets in a neat and professional manner to the satisfaction of the Owner.

G. The Contractor shall install outlets in layouts shown in the attached drawings.

H. The Contractor shall label outlets as shown on the drawings and specified below or per Owner's Standard Specification.

I. All information outlets shall be installed per manufacturer instructions to ensure a manufacturer-certified link or channel solution.

END OF SECTION

SECTION 27 16 19
COMMUNICATIONS PATCH CORDS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.2 DEFINITIONS

A. See Section 27 05 00 - Common Work Results For Communications

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. See Section 014219 - Reference Standards.

C. TIA/EIA 568B

1.4 SYSTEM DESCRIPTION

A. A single manufacturer copper solution shall be installed for the entire project.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Copper Patch Cords:

1. Cat 6 Modular Cord, blue for data applications
2. Cat 6 Modular Cords, white for wireless access points

B. Optical Fiber Patch Cords:

1. Multi-mode patch cords:
   a. Duplex LC connectors, 50/125 micron, OM3, aqua, 1 meter
   b. Duplex LC connectors, 50/125 micron, OM3, aqua, 3 meters
   c. Duplex LC to SC, 50/125 micron, OM3, aqua, 1 meter
   d. Duplex LC to SC, 50/125 micron, OM3, aqua, 3 meters
2. Single-mode patch cords:
   a. Duplex LC connectors, single-mode, yellow, 1 meter
   b. Duplex LC connectors, single-mode, yellow, 3 meters

c. Duplex LC to SC, single-mode, yellow, 1 meter

d. Duplex LC to SC, single-mode, yellow, 3 meters

PART 3 - EXECUTION

3.1 INSTALLATION

A. Copper Patch Cords:

1. The Contractor shall provide patch cords of the type/category matching the horizontal cable in the quantity of one pair per faceplate or surface mount box, plus 20 percent. The Contractor shall leave the appropriate number of cords, boxed or bagged, in each network room.

2. Provide a mix of patch cord lengths in each communications space to enable a neat and orderly patching arrangement, utilizing the rack-mounted horizontal and vertical cable management.

3. The Contractor shall leave the appropriate number of cords, boxed or bagged, in each network room.

B. Optical Fiber Patch Cords:

1. The Contractor shall provide 2-strand zip cord optical fiber patch cords to activate 50 percent of all fiber data ports, bagged or boxed in each network room. Fiber patch cords shall match the type and optical performance grade of the installed fiber.

2. Provide a mix of patch cord lengths in each communications space to enable a neat and orderly patching arrangement, utilizing the rack-mounted horizontal and vertical cable management.

3. Coordinate exact fiber optic patch cable equipment end connector type with Owner and network equipment vendor.

END OF SECTION

SECTION 27 18 00
COMMUNICATIONS TESTING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Section 27 05 00 - Common Work Results For Communications

1.2 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association.

B. TIA/EIA 568B

C. BICSI TDMM latest edition

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall perform validation testing on all voice and data communications cables installed as part of any project. This testing shall verify that the cable has been installed properly and has the specific characteristics required by the project.

B. The owner reserves the right to be present during any testing.

C. The Contractor shall provide all required test equipment and personnel necessary to support the certification and validation tests prescribed in this section.

D. The Contractor shall provide a listing of the test equipment proposed for use for all certification testing.

3.2 CATEGORY 6 AND 6A COPPER CABLES

A. All category 6 and 6A field testing shall be performed with an approved Level III balanced twisted-pair field test device.

B. All installed category 6 and 6A links shall perform equal to or better than the minimum requirements as specified by the current ANSI/TIA/EIA standards for Category 6 or 6A. If the cable manufacturer has a separate, more stringent set of test standards required to certify the total solution being installed, the Contractor shall use the more stringent requirements.

C. Category 6 and 6A balanced twisted-pair horizontal and backbone cables, whose length does not exceed 90 m (295 ft) for the basic link, and 100 m (328 ft) for the channel shall be 100 percent tested according to ANSI/TIA/EIA-568-C. Test parameters include wire map plus ScTP shield continuity (when present), length, NEXT loss (pair-to-pair), NEXT loss

(power sum), ELFEXT (pair-to-pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.

D. The Contractor shall provide the Owner with printed and electronic forms of all test results. Test results shall be unedited and as presented by the tester software. With the test results, the contractor shall provide software from the tester manufacturer to enable viewing of test results in native format. If the software is not available, test results may be provided in comma-delimited text format. This must be pre-approved by the Owner.

3.3 COAXIAL CABLES

A. The Contractor shall test all coaxial cables per ANSI/SCTE ANSI/SCTE 15 2001 (Formerly IPS SP 100). Tests shall include characteristic impedance, conductor resistance, the velocity of propagation (VOP), structural return loss (SRL), and attenuation from 5 - 1000 MHz.

3.4 COPPER TEST EQUIPMENT

A. All balanced twisted-pair field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of testing.

B. The Contractor shall set the testers to the correct cable, by manufacturer and name, to ensure correct parameters are used during testing. Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.

3.5 FIBER OPTIC TESTING

A. The Contractor shall test all optical fiber strands for insertion loss and length. The Contractor shall perform bi-directional OTDR tests on all OSP optical fiber strands.

B. The Contractor shall perform bi-directional insertion loss testing at 850 nm and 1300 nm for multimode cabling using the Method B (1-jumper) test procedure as specified in ANSI/TIA/EIA-526-14A.

C. The Contractor shall perform bi-directional insertion loss testing at 1310 and 1550 for single-mode cabling using the Method A.1 (1-jumper) test procedure as specified in ANSI/TIA/EIA-526-7.

D. The Contractor shall determine and record length using an OTDR, optical length test measurement device, or sequential cable measurement markings.

E. The Contractor shall calculate the allowable attenuated loss based on final installed length, attenuation coefficient, and connector loss.

F. Prior to activation of any network electronics utilizing project fiber, fiber test results must be submitted for review and approval. Fiber test results should also be submitted as a part of the final project documentation package.

G. The Contractor shall remediate any strands testing above the calculated limit as determined by the designer.

H. The Contractor may, at their expense, have a third party terminate the fiber in order to achieve this limit. Third-party installers must be listed as subcontractors in the bid documents. Contractors may list this subcontractor as "tentative."

I. The owner reserves the right to have third-party testing to confirm the test results. The Contractor shall remediate, at their expense, any strands exceeding this limit by third-party testing.

J. The Contractor shall provide the Owner with printed and electronic forms of all test results. Test results shall be unedited and as presented by the tester software. The Contractor may provide supplemental summaries generated by the Contractor. The Contractor shall provide Fiber performance calculation worksheets and fiber link attenuation records as illustrated in Section 21 (Figures 21.14 and 21.15) of the BICSI Telecommunications Cabling Installation Workbook, Technician, 2nd Edition.

3.6 FIBER TEST EQUIPMENT

A. All optical fiber test equipment shall be factory calibrated as recommended by the field test equipment manufacturer. The calibration certificates shall be provided for review prior to the start of testing.

3.7 BONDING AND GROUNDING

A. All bonds installed by the contractor shall be tested for impedance with an earth-ground resistance test in its two-point setup, such as a LEM Handy GEO tester. The Contractor shall place a QA label (with the date and inspector) in proximity to each bond tested.

B. The Contractor shall test all grounding conductors, once installed, for current. The Contractor shall measure AC and bi-directional DC current. The Contractor shall report any AC current over 1 Amp. The Contractor shall report any DC current, either direction, over 500milliamps.

C. Test all bonds for a maximum impedance of 0.1 ohm using a two-point impedance test. Contractors shall remediate any bond above 0.1 impedance.

D. Test all bonds for a maximum impedance of 0.1 ohm using a two-point impedance test. Contractors shall remediate any bond above 0.1 impedance.

END OF SECTION

SECTION 27 41 16.28
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR CONFERENCE ROOMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, engineering, materials, equipment, transportation, and any other services as required for a complete audiovisual system installation as shown in this specification.

B. Related products provided under another Section:

1. 120V power

2. Conduit, junction boxes, and metallic raceways

C. Related Sections

1. Section 270500 - Common Work Results for Communications Systems

2. Section 271513 – Copper Horizontal Cabling

1.2 REFERENCE STANDARDS

A. Design, manufacture, test, and install telecommunications cabling networks and audiovisual systems per manufacturer's requirements and in accordance with NFPA-70 (National Electrical Code), state codes, local codes, requirements of authorities having jurisdiction, and particularly the following standards:

1. AVIXA 10:2013 - Audiovisual Systems Performance Verification

2. AVIXA F501.01:2015 – Cable Labeling for Audiovisual Systems

3. AVIXA RP-C303.01:2018 – Recommended Practices for Security in Networked AV Systems

4. AVIXA F502.01:2018 – Rack Building for Audiovisual Systems

5. AVIXA A102.01:2017 – Audio Coverage Uniformity in Listener Areas

B. Related products provided under another Section:

1. 120V power

2. Conduit, junction boxes, and metallic raceways

a. SUBMITTALS

C. Comply with the submittal procedures of Section 270500 - Common Work Results for Communications Systems.

D. Submittal requirements:

1. Product Data Brochures

2. Shop Drawings

3. Record Drawings

1.3 SYSTEM DESCRIPTION

A. General:

1. The intent of this document is to provide all pertinent information to allow the contractor to bid the labor, supervision, tooling, and miscellaneous consumables to provide a complete audiovisual system. It is the responsibility of the contractor to include any and all items required for a complete system if not identified in these specifications or drawings.

B. Scope of Work:

1. Supply and install a turnkey audiovisual system, to include equipment and materials, whether specifically mentioned herein or not, to ensure a complete and operating system.

2. Generate submittal information for the complete fabrication, installation, and wiring of the system. Provide the on-site installation and wiring and provide ongoing supervision and coordination during implementation.

3. Provide for the initial adjustment of the systems as herein prescribed and provide test equipment for the system checkout and acceptance tests. Prior to the systems acceptance tests submit an initial testing and tuning report showing methods and results for tests performed.

4. Supply and configure all software (including custom software as required) needed to operate the system with the functionality specified.

5. Provide on-the-job training in the operation and maintenance of the systems for personnel designated by the Owner.

6. Provide a one-year warranty for systems installed.

PART 2 PRODUCTS

2.1 SUPPLIER/INSTALLERS

A. General Qualifications:

1. The firm has been in business providing similar services required by this section for not less than five years.

2. The firm can outline the general scope of past projects, normal staffing levels, and union status of shop and field installation personnel.

3. The firm can list a minimum of three projects of similar scope successfully completed in the past 24 months, indicating the location, type of system installed, total contract amount, date completed, and include persons and telephone numbers to contact.

4. The firm can submit confirmation of current state or local contracting licenses, as required to perform the work under this section.

5. The firm shall be an authorized supplier and installer for all equipment.

B. Sub-Contract:

1. No sub-contract will be permitted unless specifically identified in the bid submission.

2. The Audiovisual Contractor shall have sole responsibility for the satisfactory implementation of each system, regardless of any subcontract arrangement.

2.2 EQUIPMENT

A. Provide equipment as specified in the Equipment Schedules located on the drawings.

B. Supply the latest model, available at the time of bidding, of each piece of equipment.

C. Materials: Supply materials and equipment that shall be new and shall meet or exceed the latest published specifications of the manufacturer.

2.3 CUSTOM FABRICATION

A. Electrical Power Connections: Electrical power junction boxes and circuits will be provided by others.

B. Provide required interconnections to the power system from these junction boxes to the equipment and equipment racks.

C. Remote Control Panels and Interface Plates. Fabricate with 1/8-inch-thick #6061-T6 aluminum material.

D. Finish brushed with 150 grit paper. Anodized finish is to be white, or as approved by the Architect.

E. Equipment Rack: Provide power receptacle strips, with "U" ground outlets. Power receptacle strips shall be mounted on the rear interior of the rack space on the left side as viewed from the rear. Insulate power receptacle strips from the rack. Power receptacle strips shall be Middle Atlantic or approved equal. Provide UL-approved LED work light magnetically attached on the upper left interior panel of each rack space.

F. Labeling: Provide permanently mounted 1/32" thick by 1/4" high black lamicoid or anodized, brushed aluminum labels with 1/8" engraved lettering for each piece of

equipment and every user-adjustable control and input on the audiovisual equipment. Provide 3/8” to 1/2” high P-touch or Dymo type labels on the back of each piece of equipment. The label should be white with black lettering.

G. Rack Shelves/Mount Adapters: Provide the appropriate factory or custom rack shelves/mount adapters for equipment installed in the audiovisual equipment rack, whether specifically itemized or not. Acceptable manufacturers for custom rack adapters: Middle Atlantic, Lowell, and Atlas Sound.

H. System Functional Diagrams: Provide reduced-size as-built functional diagram(s) for the control, audio and video system. Frame with acrylic cover, or laminate drawing, and mount adjacent to the equipment rack.

I. Seismic Safety: Mount and brace permanently installed equipment to the building structure to minimize potential damage to personnel or equipment from foreseeable seismic events. Physically bolt audiovisual equipment racks to the floor to prevent toppling. Brace hanging equipment such as video projectors, loudspeakers, graphic cameras, et cetera both to minimize sway and to prevent detachment from the overhead structure.

2.4 QUANTITIES AND MISC HARDWARE

A. Reference AV Equipment Schedules on drawings.

B. Provide one (1) Crestron CBL-USBC-HD-9 user cable for AV system types as noted on drawings. Provide one (1) Liberty DL-ADR universal HDMI cable adapter ring kit in conjunction with each user cable.

C. Provide Biamp Teseria Server I/O configuration:

1. Provide all cards required to support functionality shown on one-line diagrams.

2. Provide AEC cards for all inputs, including digital channels.

3. Provide (1) spare analog 4 channel input card for future use.

4. Provide (1) spare analog 4 channel output card for future use.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that electrical requirements including junction boxes, floor boxes, ceiling loudspeaker enclosures, empty conduit, and power circuits and receptacles are in place as shown on the drawings.

3.2 INSTALLATION

A. General: Include the delivery, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system

components, equipment alignment and adjustment, and other work, whether or not expressly required, which is necessary to result in complete operational systems.

B. Storage: The contractor is responsible for secure on-site equipment storage prior to equipment installation.

C. Refer to drawings for cabling and connection type requirements. The following provides overall general cabling and connectivity requirements.

D. Physical Installation:

1. Firmly secure equipment in place unless requirements of portability dictate otherwise.

2. Mount permanently and/or provide a mechanical index ensuring precise alignment of the projected image of optical projectors.

3. Provide adequate for fastenings and supports with a safety load factor of at least ten to one.

4. Secure, plumb, and square boxes, equipment, etc.

5. Give consideration, not only to operational efficiency but also to overall aesthetic factors in the installation of equipment and cable.

E. Network Switches and Network Connected Devices

1. Validate integrity of hardware and software.

a. Maintain strict control of the supply chain and purchase only from authorized resellers.

b. Inspect all devices for signs of tampering.

c. Validate serial numbers and provide on the "as-built" documentation.

d. Update the firmware to the latest available version and provide with "as-built" documentation.

2. Change Default Passwords on all equipment.

a. Passwords should be a minimum of 15 characters.

b. Passwords should contain both upper and lower-case letters as well as symbols and numbers.

c. Provide authorized Owner's IT Representative with passwords.

d. Create multiple user credentials with appropriate privilege levels on isolated AV network switches. Provide staff with appropriate privileges levels based on their scope of work.

1) Admin User.

(a) Limit admin interface access. Create one new admin user configuration for the AV contactor's network administrator for this project.

(b) Retain admin user configuration for Owner.

2) Config User.

(a) Disable debug and modify user functionality.

3) Read-Only User.

(a) Disable the ability to make changes to the switch configuration.

3. Devices Connected Owner's Network.

a. Coordinate with Owner's IT representative(s) to obtain/set up IP address scheme, VLANs, and relevant network settings.

b. Provide manufacturer-specific requirements to Owner's IT representative(s).

c. Coordinate/facilitate network requirements for AV system implementation between manufacturer's technical support and Owner's IT Representative(s) as required.

4. Devices Connected to an isolated AV network.

a. Document the IP address scheme. Provide IP addresses for AV network-connected equipment on "as-built" one-line diagram documentation.

b. Managed switch configuration.

1) Consult with the manufacturer for recommended configurations. Unless in conflict with equipment requirements, provide the following configurations:

(a) Disable SNMP. If required, update to the latest version.

(b) After initial configuration, change to HTTPS and enable SSH. Disable auto-forward. Install a security certificate.

(c) Disable FTP/TFTP.

(d) Disable TELNET.

(e) Disable console connections.

2) VLANs - establish the following:

(a) Separate Video, Audio, and Control.

(b) Route unused ports to a separate "black hole" VLAN with no layer 3 SVI configured for it.

3) IGMPvX Configuration.

(a) Enable snooping and establish querier per manufacturer's requirements.

(b) Establish IGMP on appropriate VLANs.

(c) Apply manufacturer's configurations as required including unregistered multicast flooding, leave proxy, proxy, fast leave, and querier Interval

4) Enable jumbo frames.

5) QoS

(a) Apply manufacturer's configuration requirements.

F. Cable Installation:

1. Mark cables, regardless of length, with a permanent, non-handwritten number or letter cable markers within six inches of both ends. There shall be no unmarked cables in the system. Marking codes used on cables shall correspond to codes shown on drawings and/or run sheets.

2. Furnish screw-type terminal blocks, boards, strips, or connectors, for cables that interface with racks, cabinets, consoles, or equipment modules. Terminate wires terminating at screw-type terminals with crimp-on lugs.

3. Group cables according to the signals being carried. In order to reduce signal contamination, form separate groups for the following cables:

a. Power cables

b. Twisted Pair cables

c. Control cables

d. Video cables

e. Microphone audio cables

f. Line audio cables

g. Loudspeaker audio cables

h. Broadband RF cables

i. As a general practice, run power cables, control cables, and high-level cables on the left side of an equipment rack as viewed from the rear. Run other cables on the right side of an equipment rack, as viewed from the rear.

j. Unless otherwise called for in these specifications and drawings, use the following cables:

1) Network Cable, Jacks, and Plates – Cat 6a per 271500 Structured Cabling.

(a) AV Cat 6a cabling, jacks, and patch cords to be violet in color.

2) Plenum-rated microphone and line-level audio cable: West Penn 25291B, Liberty 20-2C- PSH-GRY

3) Plenum-rated distributed loudspeaker speaker cable: West Penn 25224B, Liberty 18-2C-P- BLK

4) Plenum-rated control cable: West Penn D25350, Liberty LLINX-U-Pn.

k. Acceptable cable manufacturers: West Penn, Canare, Belden, Extron, Covid, Gepco, and Liberty.

l. Provide a service loop of appropriate length within racks and at boxes or points of termination.

m. Install no cable with a bend radius less than that recommended by the cable manufacturer.

n. Clearly identify cable terminated in a floor pocket with permanent, indelible labels within 6" of the cable connectors. Provide strain relief for cables. Provide a minimum of 3' of free cable coiled in the floor pocket. Use Velcro-style wrap to group similar cable types. Use of wire ties is not permitted.

o. Use plenum-rated cable in plenum-rated spaces. Where plenum-rated cable is used, provide plenum-rated and approved tie-wraps and supports (Thomas & Betts #TYV525M, or approved equal).

G. Programming

1. The AV contractor agrees the Owner has purchased the control code from the contractor and the Owner will be provided the final control code at the end of the project.

2. Contractor to provide touch screen development sessions with the Owner as required to develop the graphic user interface. Several rounds of GUI review and comment are anticipated.

3.3 FIELD QUALITY CONTROL

A. Initial Tests and Measurements: Before final adjusting and acceptance tests are scheduled, perform system checkout. Furnish required test equipment and perform work necessary to determine and/or modify the performance of the system to meet the requirements of this specification. Include the following:

1. Test audio, video, RF, optical, and remote-control systems for compliance with the functional requirements and Performance Standards.

2. Adjust, balance, and align equipment for optimum quality and to meet the manufacturer's published specifications.

3. Prepare and maintain documentation of performance tests, including numerical values of established equipment settings, for reference during the System Acceptance Tests. Submit final results prior to scheduling Final Acceptance Tests Manual.

B. Audio System:

1. Loudspeaker-Line Impedance: Measure the impedance at 250 Hz, 1 kHz, and 4 kHz and the resistance of each loudspeaker line leaving the sound equipment rack with the line disconnected from its normal driving source. For lines to full-range distributed loudspeaker systems, measure the magnitude of impedance at 1 kHz.

2. Hum and Noise Level:

a. Measure the hum and noise levels of the overall system for each microphone input channel and line-level input channel.

b. Adjust gain controls for optimum signal-to-noise ratio so that full amplifier output will be achieved with 0 dBm at a line-level input.

c. Terminate line-level inputs with shielded resistors of 150 and 600 ohms, respectively, for these measurements.

d. Disconnect the loudspeaker lines and terminate the power amplifier outputs with power resistors for these measurements. The value of the load resistor shall be within 5% of the nominal load impedance of the amplifier under test. The power rating of the resistor shall equal the power rating of the amplifier.

e. Frequency Response of the System:

1) Measure the frequency response using the audio systems as described in Part 1. Adjust gain controls and equalizers to provide the octave-band sound levels as specified.

2) Programmable Equalizers: Provide the necessary controller with a full audio spectrum display for the adjustment of programmable equalizers during system checkout. Do not provide equalizer programmers with the systems.

f. Uniformity of Coverage: Measure octave band of the pink-noise test signal, centered at 4 kHz, played through the loudspeaker system.

g. Power-Output and Signal-Level Adjustment within System:

1) Measure the electrical distortion of the overall system for each line-level input channel.

2) Adjust gain control as for the tests specified herein.

3) Apply a 1-kHz sine-wave signal from an oscillator having less than 0.5% total harmonic distortion at the input tested, at a level required to produce full amplifier output. Note that a pad with 150-ohm output impedance is required for driving the microphone-level input in accordance with the EIA standard.

4) Use a distortion analyzer to measure the output level and the total harmonic distortion of the amplification and control equipment. In the absence of a distortion analyzer, a high input impedance measuring device such as a DMM may be used to measure the output level. Lack of clipping or apparent deformation of a sine-wave input signal at the power-amplifier output, as seen on the oscilloscope, may serve as evidence that distortion of amplification and control equipment is within acceptable limits.

5) Make measurements with loads actually incurred in the system operation. Power-amplifier loads shall be power resistors equal to the nominal load impedance of the output terminals used in the system.

h. Loudspeaker Polarity

1) Perform polarity checks of loudspeaker lines by means of a polarity tester or use DC source at one end of each line and a voltmeter at the other end. Loudspeaker lines shall be identically polarized with respect to color-coding.

2) Test polarity of the loudspeakers using a sine-wave test signal warbled about 500 Hz. The listener shall be located on-axis to the loudspeaker. Switch the loudspeakers from nominally in polarity to nominally out of polarity with respect to the selected loudspeaker. With the loudspeakers in proper polarity, the quality and clarity of the music or speech should be greater, and the warble test signal should clearly come to the surrounding space from the loudspeaker.

i. Freedom from Parasitic Oscillation and Radio-Frequency Pickup:

1) With systems set up for each mode of operation specified in the functional requirements, check to ensure that systems are free from spurious oscillation and radio-frequency pickup, in the absence of audio input signal and when the system is driven to full output at 100 Hz.

2) Employ an oscilloscope having at least 5 MHZ bandwidth for these checks.

3) Apply slow sinewave sweep from 50 Hz to 5 kHz at a level of 6 dB below rated power-amplifier output voltage to each system. Listen carefully for buzzes, rattles, and objectionable distortion.

4) Correct causes of these defects unless the cause is clearly from other than the sound amplification system's equipment and installation, in which case bring the cause to the attention of the Owner and Architect.

5) Audio Test Signal Paths: Verify operation from source inputs through system components to signal destinations.

C. Control System:

1. Verify operational functions at each control interface position.

2. Verify operational functions of the control system and interfaced devices.

3.4 INSTALLERS / TECHNICIANS / ENGINEERS

A. Crestron Training requirements for Contractors

1. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof of all components listed herein shall execute the tests specified in this section.

2. Training Certifications:

a. Engineers commissioning the digital media system shall hold a Crestron Digital Media Certified Engineer (DMC-E) certification.

3.5 SYSTEM TESTING AND COMMISSIONING

A. Testing

1. The contractor shall verify that all components of the system are installed according to the manufacturer’s specifications and are compliant with Division 27 specifications.

2. The contractor shall perform all internal testing and confirm system completion and functionality prior to requesting the Owner and Consultant commissioning date.

B. Commissioning

1. The contractor shall request Owner acceptance testing requirements and documentation.

2. The contractor shall perform acceptance testing and commissioning activity with the Owner and technology consultant.

3.6 OWNER TRAINING

A. Provide on-the-job training by a suitably qualified instructor, to designated personnel, to instruct them in the operation and maintenance of the systems.

B. Arrange with the equipment manufacturer for such instruction, at no additional cost, in the event qualified instructors are not available on staff for certain sophisticated equipment.

C. Schedule the first training after the systems are operational. Provide a minimum of 4 hours of training (total) on the systems included in this specification.

3.7 CLEANUP AND REPAIR

A. Upon completion of the work, remove refuse and rubbish from and about the premises, and shall leave the relevant areas and equipment clean and in an operational state. Repair damage caused to the premises by the installation activities, at no cost to the Owner.

3.8 PROTECTION OF WORK

A. During the installation, and up to the date of final acceptance, protect finished and unfinished work against damage and loss. In the event of such damage or loss, replace or repair such work at no cost to the Owner.

END OF SECTION

SECTION 27 41 51
CATV/SATV DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections

1. Section 270500 - Common Work Results for Communications

2. Section 270528 - Communications Pathways

3. Section 271800 - Communications Testing

1.2 SECTION INCLUDES

A. CATV television distribution systems using a community antenna cable television cable service as the signal source.

B. SATV television distribution systems using a satellite television service as the signal source.

C. Horizontal cabling system including coaxial cable, amplifiers, taps, and connectors.

D. Backbone cabling system including coaxial cable, amplifiers, splitters, and connectors.

1.3 SUBMITTALS

A. Comply with the submittal procedures of Section 270500 - Common Work Results for Communications.

B. Submittal requirements:

1. Product Data Brochures

2. Shop Drawings

a. When backbone cabling risers are shown on project drawings, including any proposed changes to backbone cabling on shop drawings.

b. When backbone cabling risers are not shown on project drawings or when project drawings are not developed, include all backbone cabling on shop drawings.

3. Record Drawings

a. Primary cable routes

b. Outlet or termination locations

c. Labeling

4. Test Results

1.4 SYSTEM DESCRIPTION

A. Provide RG-6 cables for TV and audiovisual outlets. Include taps, connectors, adapters, and components necessary for a complete installation.

B. Provide coaxial backbone cabling as shown on project riser drawings. Include amplifiers, splitters, and connectors necessary for a complete installation.

C. Design Criteria:

1. Provide CATV system components rated for a minimum of 50-1000 MHz.

2. Signal flow shall be on a bi-directional basis.

3. CATV outlet locations to measure between 3-6 dbMV. Contractor to perform loss calculations to ensure tap values meet or exceed the design intent of the CATV system.

D. Design Guidelines for Coaxial Cabling

1. Horizontal cable shall be installed in a star topology in a continuous run directly from the TER/TR.

2. Cables shall not traverse floors. Horizontal cabling shall be served from a room on the same floor as the WAO, unless otherwise noted. Cables that must be routed through floors and utilize the ceiling space of the floor below shall not be served from the TER/TR on the lower floor.

3. Cabling shall be free of surface damage, kinks, excessive twists, and visible anomalies.

4. All wire and cables are to be plenum rated

E. Design Guidelines for Backbone Coaxial Cabling

1. The backbone coaxial cabling system shall be designed to conform to the requirement of ANSI/EIA/TIA-568-C.4. In conformance with this standard, the cabling system shall be designed in a bus topology originating from the MDF to each IDF.

2. All indoor fiber, wire, and cables are to be plenum rated.

3. All communications materials used shall be UL listed. When such listing is not available for a piece of equipment, it will be accepted provided it is furnished in accordance with submittals and is approved by the Owner.

1.5 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of CATV/SATV system Installer. Include quarterly adjusting as required for optimum system performance.

PART 2 PRODUCTS

2.1 HORIZONTAL COAXIAL CABLE

A. Application: Horizontal RG-6 coaxial cabling suitable for providing CATV service in an indoor environment.

B. RG-6 Coaxial Cable:

1. Consists of an 18 AWG center conductor with a foam FEP dielectric material and quad shielding.

2. Conforms to performance requirements for Series 6 coaxial cable.

3. UL tested and listed as CMP.

C. Manufacturer:

1. CommScope

a. 4112704/10 | 2227V WHRL RG6 QD 1000, RG-6 plenum-rated coaxial cable, white

2. Or equal

2.2 CATV DIRECTIONAL TAP

A. Application: Termination of horizontal RG-6 coaxial cabling onto a wall-mounted apparatus.

B. Directional Taps:

1. Frequency: Performance to 1000 MHz

2. Outputs: 8 x 8 F-type connectors

3. Contains a built-in ground block and RFI shielding for up to 120 dB.

C. Manufacturer:

1. Blonder Tongue

a. #DGT-8, indoor directional tap, 8-output

2. Or equal

2.3 CATV CONNECTORS

A. Application: Termination of horizontal coaxial cabling using an F-type connector.

B. F-Type connectors for WAOs:

1. UL listed 75 Ohm F-type connectors for RG-6 and RG-59 coaxial cabling.

2. Performance rating up to 3 GHz.

3. Supports both push and screw-style termination.

C. F-Type connectors for termination to directional tap:

1. Hex crimp style

2. Female to female coupler.

3. UL listed 75 Ohm F-type connectors for RG-6 coaxial cabling.

D. Manufacturer:

1. F-Type connectors for WAOs:

a. CommScope

1) #108009432 | M81C-COUPLER, F-type connector, white

b. Or equal

2. F-Type connectors for termination to directional tap:

a. Blonder Tongue

1) #3587, “BTF-56” F-type connectors, hex crimp

b. Or equal

2.4 BACKBONE COAXIAL CABLE - SERIES 11 RATED

A. Application: Backbone RG-11 coaxial cabling suitable for providing inter-building CATV service.

B. RG-11 Coaxial Cable:

1. Consists of a 14 AWG center conductor with a foam FEP dielectric material and quad shielding.

2. Conforms to performance requirements for Series 11 coaxial cable.

3. UL tested and listed as CMP.

C. Manufacturer:

1. CommScope

a. #4101204/10 | 2287V WTRL RG11 QD 1000, RG-11 plenum-rated coaxial cable, quad shield, white

2. Or equal

2.5 CATV CONNECTORS

A. Application: Termination of backbone coaxial cabling using an F-type connector.

B. F-Type connectors:

1. UL listed 75 Ohm F-type connector for RG-11 coaxial cabling.

2. Performance rating up to 3 GHz.

C. Manufacturer:

1. Belden

a. #716SNS1P11HQ, 7/16” F-type connector for RG-11 quad-shield cable

2. Or equal

2.6 CATV SPLITTER

A. Application: Trunk-line splitter for backbone coaxial cabling onto a wall-mounted apparatus.

B. Splitter:

1. Frequency: Performance to 1000 MHz

2. Outputs: 2 x F-type connectors

3. Contains a built-in ground block and RFI shielding for up to 120 dB.

C. Manufacturer:

1. Blonder Tongue

a. #SXRS-2, indoor splitter, 2-way

2. Or equal

2.7 CATV DISTRIBUTION AMPLIFIER

A. Application: Amplification of RF distribution system.

B. Distribution Amplifier:

1. Features:

a. Two-way capability with active/passive return path.

b. Hybrid IC circuitry for high output and low distortion.

c. Adjustable gain and slope controls

d. Forward patch input-side plug-in fixed attenuator and cable equalizer

e. Return path output-side fixed attenuator

f. Exceeds FCC specifications for both conducted and radiated interference at the full output level.

2. Specifications:

a. Frequency range: 49-1000 MHz

b. Gain: 30 or 43 dB, Contractor to determine based on loss calculations

c. Gain Control Range: 10 dB

d. Slope Control Range: 8 dB

e. Input Return Loss: 16 dB

f. Output Return Loss: 16dB

g. Noise Figure: 8.5 dB

h. Channels: 150

i. Output Level: 32/40 dBmV

C. Manufacturer:

1. Blonder Tongue

a. #5800-xx (where “xx” represents the dB gain value), “BIDA” series distribution amplifier

b. #5479, “BIDA” series plug-in cable equalizer, 1000 MHz

c. #5411A, “BIDA” series plug-in fixed attenuator

2. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install in accordance with manufacturer's instructions to ensure a manufacturer-certified solution.

2. The Contractor shall be responsible for verifying actual footages and distance identified on drawings.

3. The Contractor shall be responsible for verifying that conduits and raceways are ready for occupancy before cable placement.

4. The Contractor shall assume responsibility for difficulties or damage to the cable during installation.

5. The Contractor shall install all horizontal cables free of surface damage, kinks, excessive twists, and visible anomalies. Damaged cable shall be replaced at the Contractor's expense. Horizontal cables damaged by others during construction shall be replaced by the Contractor under unit pricing specified in bid documents.

6. Cold-weather Installation: Bring cable to room temperature before de-reeling. Heat lamps may not be used for heating.

7. The cable may not be installed in the same raceway as power cable.

8. Coaxial cable shall not be spliced except on plywood backboards in wire closets or in cabinets designated for the purpose.

9. Install passive circuit devices, such as splitters and attenuators, in wire closets or cabinets. Do not install attenuators as part of the user-interface device outlets.

B. Horizontal Coaxial Cabling

1. Provide coaxial cabling to TV and audiovisual outlets as indicated on construction drawings.

2. Provide a 10-foot service loop at the end of each cable. For the service loop within the TER/TR, route slack in the overhead cable runway.

3. Neatly dress cables to their respective wall-mounted directional tap using Velcro cable ties and/or rack cable management loops.

4. Bond components to communications grounding systems.

5. Terminate horizontal RG-6 coaxial cables with F-type connection jacks onto shared WAO faceplates with CAT6 cabling.

C. Coaxial Backbone Cabling

1. Provide distribution amplifiers, equalizers, and attenuators as required for a complete CATV backbone installation.

2. Coaxial backbone cable shall terminate onto a high-performance splitter and distribution amplifier in each MDF/IDF.

3. Coupler isolation values shall be selected, connected, and bridged to the floor amplifiers to provide a balanced signal output level at each tap.

4. Bond components to the communications grounding system.

5. Provide RG-11 patch cords between the splitter, amplifier, and directional taps. Refer to Section 271533 - Communications Horizontal Coaxial Cabling for additional requirements.

6. Provide F-type connectors as required.

D. Testing and Inspection

1. The frequency response of the system shall pass 5 MHz to 1000 MHz.

2. Amplitude response for this spectrum shall be +/- 5 dB with respect to the line represented by normal cable tilt.

3. Taps, splitters, and other passive equipment shall be of the total shielding type, using a sealed metal or aluminum case so as to minimize re-radiation and ingress.

4. Terminating resistors with 75-ohm impedance shall be installed at unused ports and feeder line ends.

3.2 LABELING

A. In accordance with the Owner’s standards for labeling, the Contractor shall label the communications faceplates, taps, and amplifiers using a mechanical labeler.

B. Coordinate with the Owner for existing labeling schemes and requirements. At a minimum, the following shall be reflected in the faceplate and patch panel labeling schemes:

1. Alpha or numeric designator

2. Text size shall be a minimum of 1/4" high

3. Handwritten labels are not acceptable for final configurations

C. Labeling shall be done in accordance with relevant standards such as ANSI/TIA-606-B. Any deviations shall be approved by the Owner’s Representative.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate and maintain CATV/SATV equipment.

1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing and maintaining equipment.

2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.

END OF SECTION

SECTION 27 53 23
PUBLIC SAFETY RADIO COMMUNICATIONS SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Base Bid work scope to include infrastructure to support entire system installation, and site survey to determine required coverage areas.

1. Infrastructure to include conduit pathways for entire antenna riser, sleeves at each floor for extension of horizontal cabling from riser location, roof penetration, and weather head, power to booster equipment.

2. Include labor, testing equipment required to survey RF signal coverage within the building. Survey to be completed upon substantial completion of structure and glazing. The report shall indicate all areas where signals from public transmission fail to meet the signal strength requirements outlined in Bid Alternate below.

B. Bid Alternate work scope to include installation of an in-building radio signal amplification system to provide complete coverage in the building for the public safety agencies as required by the local fire department and other authorities having jurisdiction, to allow for operation in one or multiple frequency bands allocated to Public Safety, including VHF, UHF, 800 MHz NPSPAC and new 700-800 MHz Spectrum. System users shall be able to receive and transmit radio broadcasts from their portable radio units within the building as follows:

1. Provide 99% radio coverage for critical areas: Emergency command center, fire pump room, stairwells, exit passageways, elevator lobbies, standpipe locations, sprinkler valve locations and similar critical areas.

2. Provide 95% radio coverage for general building areas

3. The system shall comply with the requirements of:

   a. UL2524 1st Edition

   b. NFPA 72-2010

   c. NFPA 1221-2016

   d. IFC-2018

   e. FCC rules (parts 22, 90 and 101)

   f. Local Fire Department and AHJ.

4. System components shall include the following as a minimum:

   a. Signal Boosters/Bi-Directional Amplifiers

b. Plenum-rated Coaxial Cable

c. Antennas

d. Cable taps

e. Connectors

f. Power dividers

g. Additional raceways/fire protection ratings (not included in the base bid)

h. Power Supplies

i. Annunciation

C. The entire system shall meet with the approval of the Fire Department, the Building Department, and all other agencies and authorities having jurisdiction (AHJ).

D. The work in this section shall include the responsibility for all filings with the AHJ. This responsibility shall include furnishing of required quantities of floor plans, descriptive notes and/or specifications, wiring diagrams, shop drawings, and amendment forms.

E. Early completion of the in-building emergency radio communication enhancement system will be required to allow for a Certificate of Occupancy to be obtained in accordance with the Owner's schedule.

F. Any permits necessary for the installation of the work shall be obtained prior to the commencement of the work. All permit costs and inspection fees shall be included as part of the required work.

1.2 RELATED REQUIREMENTS

A. Section 01 23 00 - Alternates: Descriptions of items, administrative requirements.

B. Section 01 30 00 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.

C. Section 07 83 13 - Penetration Firestopping.

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Electrical system grounds.

E. Section 26 05 35 - Conduit

F. Section 28 31 00 - Fire Detection and Alarm System

G. Section 27 10 00 - Structured Cable System: Surge Protection for Wiring Systems

1.3 PRICE AND PAYMENT PROCEDURES

A. Allowances: See Section 01 21 00 - Allowances, for cash allowances affecting this section.

B. Alternates: See Section 01 23 00 - Alternates, for product alternatives affecting this section.

1.4 REFERENCE STANDARDS

A. NFPA 72 - National Fire Alarm Code

B. NFPA 780 - Lightning Protection

C. IFC - International Fire Code

D. UL 2524 In-Building 2-Way Emergency Radio Communication Enhancement Systems

E. 47 CFR 90.219 Federal Communications Rules

F. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination with Roofing Work: Ensure adequate attachment of antenna Weatherhead and associated waterproofing is coordinated and installed without damage to roofing.

B. Preinstallation Meeting: Convene a meeting when structure and glazing are substantially complete to review results on the radio coverage survey. Require attendance by representatives of owner’s representative, engineer and installers whose work will be affected, and AHJ, if available.

1.6 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Prior to installation submit the two-way radio communications enhancement system, if used in lieu of a two-way in-building wired emergency communications system, to the AHJ for approval by the AHJ.

C. Specification Compliance letter, indicating Comply, Deviate, Non-Compliance for each line item.

D. Shop Drawings:

1. Indicate location and layout of each component, cable routing, taps/splitters.

2. Proposed test forms for riser and station connections.

E. Product Data: Provide dimensions and materials of each component, indication of testing agency listing, and installation instructions.

F. Manufacturer-certified installer documentation.

G. Testing technician certification of one of the following: FCC General Radiotelephone Operator License or APCO Radio Technician Certification

H. Certificate of Insurance

I. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

J. System Acceptance Testing Report: Submit a copy of the certification agency's approval.

K. Operation and Maintenance Data: Provide recommended inspection and testing plan, including recommended intervals, to achieve periodic maintenance as recommended by the manufacturer; provide customized plan reflecting actual installation configuration with specific installed components identified.

L. Project Record Documents: Record actual locations of DAS antennas, power supplies, signal boosters, annunciators, and routing of system conductors in project record documents. Include summary of electronics settings.

M. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with the manufacturer.

1.7 QUALITY ASSURANCE

A. Products: Listed, classified, and labeled as suitable for the purpose intended.

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

1.8 WARRANTY

A. Manufacturer to provide a three (3) year warranty of the installed system against defects in material and workmanship. All repair labor and materials shall be provided at no cost to the owner.

B. The warranty period shall start on the date the system is accepted by the AHJ.

C. A maintenance contract shall be made available if requested by the owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:

1. Honeywell – Farenhyt Series

2. 3M Interam – Endothermic Mat E-5A-4 (2-hour fire protection wrap)

3. See Section 01 25 00 for Substitution Procedures

2.2 SYSTEM REQUIREMENTS

A. The system shall be complete with all components and wiring required for compliance with all applicable codes and regulations, and for its operations described hereinafter.

B. The system shall be sufficiently modular so as to allow for the additional capacity to be added if needed to accommodate future coverage requirements.

C. The system shall be equipped with lightning protection in accordance with NFPA 780.

2.3 COMPONENTS

A. All Components: Complying with applicable requirements of a nationally recognized testing agency.

1. In-building emergency radio communication enhancement systems for emergency responders are an integral component of the life safety equipment of a building or structure. The primary function is to provide reliable emergency responder communications at the required signal strength within the specified areas.

2. External filters, attachments, or other aftermarket modifications of the original equipment shall not be accepted.

B. Signal Booster:

1. The signal booster shall be a class B Public Safety type as designated by the FCC and as required by the AHJ.

2. All signal boosters and other active system components must have FCC certification prior to installation. The FCC ID must be shown on the product datasheets and technical submittals and also displayed on the product as required by the FCC.

3. The signal booster shall be set and tuned by the equipment manufacturer to pass frequencies as specified by the local fire department.

4. To reduce the possibility of unwanted interference affecting the operation of the system, signal boosters shall be a band or channel selective type with a maximum 3dB channel bandwidth of 200KHz (Fc +/- 100KHz). Wide-band signal boosters shall not be accepted unless required to cover multiple channels within the same band.

5. Signal Boosters shall have oscillation prevention circuitry to protect the public safety radio system in case of the signal booster malfunction

6. Signal Booster gain shall be rated at a minimum of 80dB and the gain shall be adjustable in a minimum of 25dB range. System gain shall be set and documented at the time of the final system test.

7. The maximum propagation delay of the signal booster system shall be 14?s (microseconds) or as specified by AHJ.

8. The signal booster system shall include built-in automatic alarming of malfunctions of the signal booster and battery system as per referenced codes and standards. Aftermarket equipment add-ons and modifications to comply with this specification will not be accepted.

9. The signal booster system shall include six-alarm relay outputs with line termination for Fire Alarm Panel connection for monitoring the signal booster.

10. The signal booster shall be designed to allow degraded performance in adverse conditions, such as high temperatures in the event of heat from a nearby fire, voltage fluctuations, or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. under/over voltage, over/under current, over/under temperature, etc.) are not acceptable. External UPS (Uninterruptible Power Supplies) are not acceptable. It is the purpose of this specification to assure the maximum possible level of communications to public safety personnel depending upon the signal booster, even to the extent of damaging the signal booster, as long as some communications benefit can be provided during the emergency

11. All signal booster components shall be contained in a NEMA 4-type approved waterproof cabinet. All enclosures shall be painted red with signage in bright yellow or as required by AHJ.

C. Power Supplies:

1. The secondary Power source shall be dedicated to the system and shall provide at least 24 hours of 100% system operational capacity.

2. The secondary power supplies, battery chargers, and system monitoring shall be fully compliant with NFPA-72, 2010 edition and NFPA 1221, 2016 edition. The signal booster shall have both the primary and the secondary power supplies built in a fully sealed NEMA-4 type-approved enclosure.

3. System design shall be such that neither the failure of the normal power source, the transfer to an emergency source, nor the re-transfer to the normal source shall cause a change in system status.

D. Monitoring Panel:

1. A dedicated supervised monitoring panel shall be provided within the emergency command center 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:

   a. Normal AC power available

b. Signal booster trouble

c. Antenna Failure

d. Loss of normal AC power

e. Failure of battery charger

f. Low battery capacity (70% of the 12-hour operating capacity has been depleted)

g. System component malfunction

2. Annunciation of these conditions shall occur within 200 seconds, and within 24 hours of fault for Donor antenna malfunction.

3. Visual and audible annunciation within 24 hours is required for donor antenna malfunction.

4. In addition to a dedicated monitoring panel, fault conditions shall be annunciated by the fire alarm system via monitored relays.

5. The vendor shall verify the system monitoring requirements with the AHJ prior to system installation. System monitoring shall be fully compliant with the AHJ requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated on shop drawings.

B. Coordinate work with the installation of roofing and exterior and interior finishes.

3.2 INSTALLATION

A. Comply with the provisions of the National Electrical Code, NFPA 72, and applicable standards.

B. Assembly and installation of all components in the system shall comply with applicable sections of the referenced codes and standards, and the National Electrical Code.

C. Equipment shall be served via a dedicated 20A, 120V branch circuit in accordance with NFPA 72 and NEC. Provide handle locking device in the ON position for branch circuit serving system.

D. The amplifier shall be housed in a 2-hour fire-rated room, or other suitable space if approved by AHJ. Connections between riser and feeder coaxial cables shall be made within the 2-hour rated enclosure. Passage of the feeder cable in/out of the rated enclosure and

all other rated wall penetrations shall be fire-stopped in accordance with division 7 requirements.

E. RF Coaxial cable shall be fire-resistant, low-smoke type, UL classified for plenum use. Classification shall be clearly marked on the outer surface of the cable at regular intervals.

F. Riser and feeder coaxial cable shall be installed and protected with a 2-hour fire rating to ensure pathway survivability.

G. Antenna mounting

1. A 2” pipe mounting system shall be provided. Antenna mounting hardware shall attach to the pipe system

2. All hardware shall be galvanized steel with stainless steel fasteners.

3. All components shall be able to withstand a Wind Gust Rating of 120 mph.

4. Roof penetration shall utilize a 4” weather-head with “C” type conduit body located below to provide access for pulling cables. Size weather-head to accommodate minimum bend radius of coaxial cables.

H. Branch circuit and signal cabling shall be installed in rigid steel conduit, except where routed in earth or concrete, which shall comply with the provisions of specification section 26 05 34.

I. Where fire wrap is installed to provide 2-hour protection for riser/feeder pathways, install in accordance with manufacturer requirements, complete with recommended fire caulk, aluminum foil tape, and steel retention bands.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Perform a visual inspection of riser installation, antenna installation, and roof penetration

3.4 ACCEPTANCE TESTING

A. Acceptance testing for an in-building radio system is required upon completion of installation.

B. The coverage testing shall be performed in accordance with NFPA 72, National Fire Alarm and Signaling Code, 2010 edition, NFPA 1221 2016 edition, and as required by the local AHJ

C. Antenna isolation shall be maintained between the donor antenna and all inside antennas (D.A.S.) to a minimum of 20dB under all operating conditions.

D. The In-building emergency radio communication enhancement systems must provide the following signal strengths:

1. Downlink - Minimum signal strength of -95 dBm throughout the coverage area.

2. Uplink - Minimum signal strength of -95 dBm received at the AHJ Radio System.

E. Backup batteries and power supplies shall be tested under load for a period of 1 hour to verify proper operation. If within the 1 hour test period, the battery exhibits symptoms of failure, the test shall be extended for an additional 1 hour period until the integrity of the battery system can be determined.

F. All tests shall be conducted, documented, and signed by a person in possession of an FCC General Radio Telephone Operators License. All testing personnel shall be certified and authorized by the signal booster manufacturer in the installation and operation of their equipment. Personnel qualifications must be acceptable to the AHJ.

G. Each floor shall be divided into a grid of approximately 40 equal areas. A maximum of two adjacent areas (for general coverage) will be allowed to fail the test. Test locations to be established approximately in the center of each grid area – then the radio will be enabled to verify two-way communications to and from the outside of the building to the anticipated fire truck response location through the agency's radio communication system. Once the test location has been selected, prospecting for a better spot within the grid will be limited to within 3’ in any direction from the original test location.

H. Testing shall be conducted using a calibrated portable radio of the latest brand and model used by the agency/agencies who will utilize the system.

I. Isolation testing shall be performed to ensure spurious oscillations are not being generated by the subject radio communication system due to coupling (lack of isolation) between the input and output antenna systems. This test will be conducted at the time of installation and subsequent annual inspections.

J. Gain and power values of the system shall be measured. The test measurement results shall be recorded on record drawings and retained on file as required per code and for trending analysis in subsequent testing cycles.

3.5 TRAINING

A. Installing contractor shall provide owner training to include, but not limited to:

1. Location of key components

2. Mechanical and fire protection requirements of the installed system

3. Normal and abnormal annunciator status

4. Requirements for continued annual testing and monitoring in accordance with NFPA 1221

5. Requirements for two-year testing documentation retention.

3.6 CLOSE-OUT

A. All test records along with system diagrams, equipment specifications, user manuals, RF link budget calculations, battery backup calculation, and other design data shall be submitted upon completion of the project.

B. Documentation to be stored with Fire Alarm System documentation.

END OF SECTION

SECTION 28 05 00
COMMON WORK RESULTS FOR ELECTRONIC SAFETY & SECURITY

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Basic materials and methods, along with the General Requirements of Division 1, are applicable to Division 28 sections.

2. Drawings and general provisions of the contract, including General and Supplementary Conditions of Division 1, applicable to Division 28 sections.

B. Related Sections

1. Section 28 1300 - Access Control System

2. Section 28 2300 - Video Surveillance System

1.2 CONTRACTOR REQUIREMENTS AND QUALITY ASSURANCE

A. Comply with applicable local, state, and federal codes.

B. Comply with applicable requirements of recognized industry associations that produce standards for the various trades.

C. Warrant work under this specification against faulty material or Workmanship in accordance with Division 1. If the project is occupied or the systems are placed in operation in several phases at the request of Owner's Representative, then the warranty of each system or piece of equipment used shall begin on the date of substantial completion for each phase. The use of building equipment for temporary service and testing does not constitute the beginning of the warranty.

D. Equipment and material provided under this Division shall be periodically inspected and serviced by competent installers. This function becomes the responsibility of the Owner once the system is accepted by the Owner. The one-year material and Workmanship warranty is not intended to supersede normal inspection or service and shall not be construed to mean the Contractor shall provide free service for normal maintenance items such as periodic cleaning and adjustment due to normal use, nor to correct without charge, breakage, maladjustment, and other trouble caused by improper maintenance.

E. Upon completion of the contract and progressively as work proceeds, clean-up and remove dirt, debris, and scrap materials. Maintain the premises in a neat and clean condition at all times during construction. Protect and preserve access to Head-end equipment at all times. Clean items with factory finishes. Touch-up minor damage to surfaces; refinish an entire piece of equipment when sustained major damage. All electronics must be protected from dust and other airborne debris.

1.3 STANDARDS

A. The Contractor's performance of the work shall comply with applicable federal, state, and local laws, rules, and regulations. The Contractor shall give required notices, shall procure necessary governmental licenses, permits, and inspections, and shall pay without burden to Owner's Representative, all fees and charges in connection therewith unless specifically provided otherwise. In the event of a violation, the Contractor shall pay all fines and penalties, including attorney's fees and other defense costs and expenses in connection therewith.

B. Codes, Standards, and Ordinances: Design, manufacture, test, and install electronic safety and security systems per manufacturer's requirements and in accordance with state codes, local codes, requirements of authorities having jurisdiction, and particularly the following standards:

1. National Fire Protection Association (NFPA):

a. NFPA 70 - National Electrical Code

b. NFPA 72 - National Fire Alarm and Signaling Code

c. NFPA 101 - National Life Safety Code

2. Underwriters Laboratories, Inc. (UL):

a. UL 1479 - Fire Tests of Through - Penetrations Firestops

b. UL 294 - Access Control System Units

3. Americans with Disabilities Accessibility Guidelines.

1.4 COMPLETENESS OF WORK

A. The Contract Documents depict low voltage systems which are intended to be complete and functioning systems. All products, materials, labor, and programming necessary to render a fully functional system to fulfill the design intent shown on the documents shall be provided by the contractor.

B. Catalog numbers referenced throughout this Division’s drawings and specifications are intended to convey a general understanding of the type of quality of the product required. Where written descriptions differ from information conveyed by a catalog number, the written description shall govern. No extra charge shall be allowed because a catalog number is found to be incomplete or obsolete.

1.5 SUBMITTALS

A. Comply with provisions of Division 1.

B. Submit shop drawings as called for in the Specification Sections that follow.

C. Within thirty (30) days after the contract has been awarded, the Contractor to submit to the Designer for review a complete list of materials, equipment, and accessories proposed for use, listing the item and manufacturer's name only.

D. AutoCAD or Revit files requested by Contractor for use in submittals, coordination drawings, as-builts, etc., will be subject to executing a release document from the Engineer prior to the release of electronic media.

E. Based upon the aforementioned approved listing, the Contractor to submit four (4) copies of complete brochures and shop drawings of all materials, fixtures, and equipment that he proposes to use giving the names of manufacturers, trade names, and specific catalog numbers.

F. Product Data Brochures

1. Furnish original color product datasheets, describing the specification and technical requirements of the system and each component. When multiple products are listed, denote by highlighting or other forms which product they intend to use.

2. Miscellaneous cut sheets for wire, cable; terminal block connector, etc. clearly identify model numbers, manufacturer names, and miscellaneous engineering data.

3. Provide equipment quantities and model numbers for all equipment being proposed.

4. Provide engineering calculations, such as voltage drop, electrical load calculations, etc. as it relates to devices.

G. Shop Drawings

1. Provide detailed system drawings, including location and mounting requirements.

2. Complete and legible legends should be provided for each of the drawings.

3. Provide functional block diagrams.

4. Provide mounting details, indicating mounting, protective housings etc.

5. Provide wiring diagrams and point-to-point wiring schematics to panels, indicating utilized inputs and spare inputs.

6. Details of connections to power sources including power supplies.

7. Console/Rack installation, block diagrams, and wiring diagrams.

8. Denote main cable pathways or individual home runs.

H. Assurance/Quality Control Submittals

1. Certification letters stating the Contractor is an authorized reseller, installer, and extended warranty provider for the specified systems.

2. Evidence of technicians qualified for work in the form of specified manufacturer's training certification.

1.6 DELIVERY AND STORAGE

A. Insofar as possible, deliver items in manufacturers' original unopened packaging. Where this is not practical, cover items with protective materials, to keep them from being damaged. Use care in loading, transporting, unloading, and storage to keep items from being damaged.

B. Store items in a clean dry place and protect them from damage.

1.7 OPERATING AND MAINTENANCE MANUALS

A. Prior to final acceptance of the project, furnish to Owner complete bound sets of operation and maintenance manuals of instructions for operation and maintenance of all pieces of equipment and systems provided under this division of specifications.

B. Manuals to also include all submittal data on all materials and equipment. Clearly indicate items provided on this project. Included a list giving name and address of nearest supply house which carry the spare parts and name and address and phone number of Installation Contractor to be given to Owner.

C. The supplier or manufacturer shall provide thorough training of all staff assigned to those areas receiving new systems and equipment. This training shall be developed and implemented to address two different types of staff. The end-users will be trained on the features and functions of the systems, and the engineering or maintenance department will be trained on the routine maintenance and basic programming of the systems. All training will take place on-site using the fully installed and certified system.

D. Three sets of the following data are required:

1. Operating and maintenance instructions.

2. Spare parts lists.

3. Copies of approved submittal data.

4. Warranty information including any required test results.

E. Arrange each set of data in an orderly way, and bind each set in a separate 3-ring, hard-cover binder.

F. As soon as data accumulates, prepare one of the sets and deliver to the Owner's Representative, continuously updating this set as additional data is obtained.

G. At the completion of work, submit two complete sets of data to the Owner's Representative for distribution to the proper parties.

1.8 RECORD DRAWINGS

A. Provide updated drawings, denoting all changes to the construction documents and the date at which the change took place.

B. Provide updated drawings, which illustrate final field conditions; these drawings shall incorporate all changes to the construction documents.

C. Panel power schedules, denoting circuits dedicated for use.

D. Wire and cable run sheets including cable identification numbers and terminal strip designations.

E. Legends that indicate device types, symbols, abbreviations, and manufacturer's model numbers.

F. Functional block diagrams for all subsystems. Schematic diagrams for all custom circuitry and interfaces to work not in the contract.

G. Elevations for equipment and/or riser closets, which show the exact configurations and physical installation of related equipment, interface panels, power supplies, junction boxes, and equipment cabinetry.

1.9 WARRANTY

A. The Contractor shall adhere to the warranty requirement for all installations.

B. Warrant work under this specification against faulty material or Workmanship in accordance with Division 1 for a period of one (1) year that shall begin after system acceptance by the Owner. If the project is occupied or the systems placed in operation in several phases at the request of the Owner, then the warranty of each system or piece of equipment used shall begin on the date of substantial completion for each phase. The use of building equipment for temporary service and testing does not constitute the beginning of the warranty.

C. The Contractor shall submit in the bid documents any additional, contractor-specific warranties or guarantees to be offered on the project.

D. The Contractor shall provide any and all necessary documentation needed to implement this warranty and to verify the solution installation.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All materials and equipment used in carrying out these specifications are to be new and have UL listing, or listing by other recognized testing laboratories when such listings are available. Specifications and drawings indicate name, type, and catalog numbers of materials and equipment to be used as “standards” shall not be construed as limiting

competition. Unless otherwise indicated, Contractor may, at his option, use materials, and equipment when, in the judgment of the Owner's Representative, they are equivalent to that specified. Prior approval of substitutions must be given prior to submittals.

PART 3 EXECUTION

3.1 COORDINATION

A. Insofar as it is possible to determine in advance, advise the general contractor to leave proper chases and openings. Place all outlets, anchors, sleeves, and supports prior to pouring concrete or installation of masonry work. Should the contractor neglect to do this, any cutting and/or patching required is to be done at this contractor's expense. Visit the site and be informed of conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain the necessary information to completely estimate and perform the work involved.

B. Carefully coordinate with other divisions to ensure proper power requirements, grounding, fireproofing, and interlocking controls between the fire alarm system, nurse call system, and owner furnished systems.

C. Notify other tradesmen of any deviations or special conditions necessary for the installation of work. Interferences between work of various contractors to be resolved prior to installation. Work installed not in compliance with specifications and drawings and without properly checking and coordinating as specified above shall, if necessary, be removed and properly reinstalled without additional cost to the Owner.

D. Intent:

1. These sections of specifications and drawings form a complete set of documents for the electronic safety and security systems for this project. Neither is complete without the other. Any item mentioned in one shall be as binding as though mentioned in both.

2. The intent of these specifications and drawings is to form a guide for the installation of a complete system. Where an item is reasonably necessary for a complete system but not specifically mentioned, such as pull boxes, fittings, expansion fittings, support hangers, etc. provide same without additional cost to Owner.

3. Device layouts indicated on drawings are diagrammatical only. The exact location of outlets and equipment to be coordinated and governed by project conditions. The Designer reserves the right to make any reasonable changes (approximately 6 feet) in the location of junction boxes, or equipment prior to roughing in of such without additional cost to the Owner.

E. Deviations:

1. No deviations from specifications and drawings are to be made without the full knowledge and consent of the Designer.

2. Should Contractor find during the progress of work that existing conditions make desirable a modification of the requirements of any particular item, report such item promptly to Designer for his decision and instructions.

3.2 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

A. Under other Divisions, provide trenching, excavation, and backfilling. Coordinate all requirements with trades. Failure to properly coordinate this effort resulting in additional trenching, excavation, backfilling, or repairs shall be performed without additional cost to the Owner.

3.3 TESTS

A. On completion of work, installation to be entirely free of damaged materials, software errors, incomplete cable installation including terminations, labeling, and dust. Perform a thorough operation test in the presence of the Owner's Representative. Provide documentation of all test results as outlined in each system's specifications. Include labor, materials, and instruments for the above tests.

B. Prior to final observation and acceptance, test and leave in satisfactory operating condition, all systems, and equipment including but not limited to the following:

1. Access Control System

2. Video Surveillance System

3.4 INSPECTION FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for electronic safety and security systems installation.

3.5 OBSERVATIONS

A. When field observation services are a part of the project scope, the Architect office will provide periodic observation of the progress of work specified herein. The purpose of the observation is to ensure compliance with the Contractor's work with specifications and drawings. The Architect office may also observe tests required of this Contractor as called for in other sections of specifications.

B. Specifications and drawings represent work to be done in view of total project requirements. The final location of card readers, cameras, duress buttons, etc., to eliminate possible conflict with other trades is the responsibility of this Contractor. Contractor to provide all supervision required for his personnel to ensure that installation is made in accordance with specifications and drawings and all safety rules and regulations are observed. In event of conflicts of work on the project with other trades, the Contractor makes every reasonable effort to resolve conflict through meetings and discussions with other parties involved, by preparation of drawings or other appropriate action. Only after this has been done shall Architect assistance be requested through the RFI process.

C. When Architect is requested to visit the project to aid in the resolution of conflicts, or for witnessing tests, they shall be given a minimum of 48 hours notice prior to the time their presence is requested at the job site.

END OF SECTION

SECTION 28 13 00
ACCESS CONTROL SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access control software and client licenses
2. Access control panels, input/output modules, and card readers
3. Access control power supplies
4. Access control servers
5. Badging software, printers, and associated peripherals
6. Alarm initiating devices, including door position switches, request-to-exit sensors, duress buttons, and general alarm points
7. Integration with the video surveillance system
8. Interface to electrified door hardware and operators

B. Related products provided under another Section:

1. 120V power
2. Conduit, junction boxes, and metallic raceways
3. Door hardware, operators, and pushbuttons
4. Fire alarm system interface relays
5. Electromagnetic door holders

C. Related Sections:

1. Section 28 2300 - Video Surveillance System

1.2 SUBMITTALS

A. Comply with the submittal procedures of Section 28 0500 - Common Work Results for Electronic Safety & Security Systems.

B. Submittal requirements:

1. Product Data Brochures
2. Shop Drawings

3. Record Drawings

1.3 SYSTEM DESCRIPTION

A. General:

1. The intent of this document is to provide all pertinent information to allow the contractor to bid the labor, supervision, tooling, and miscellaneous consumables to provide a complete access control system. It is the responsibility of the contractor to include any and all items required for a complete system if not identified in these specifications or drawings.

B. Overview:

1. The access control system for the Nexus Mall Project will be monitored and controlled in the <ENTER LOCATION>.

2. Card readers and other alarm initiating devices will route to wall-mounted access control panels located in the telecommunications rooms and utilize the Owner's LAN for communication with the access control server in the <ENTER LOCATION>.

C. Scope of Work:

1. Provide access control software with associated license fees to support the card readers and security devices shown on the project drawings.

2. Provide software integration licenses to integrate the access control software with the specified video management software (refer to Section 28 2300 - Video Surveillance System for additional requirements) to enable automatic camera call-up upon event or alarm.

3. Provide badging licenses, card printers, ribbons, and associated peripherals for badging workstations shown on project drawings.

4. Provide access control panels with associated power supplies located in the telecommunications rooms. Panels to include controllers, reader modules, and input/output modules to support the devices shown on project drawings.

5. Provide multi-technology card readers as indicated on project drawings. Card readers to accept 125 kHz and 13.56 MHz formats.

6. Provide 500 smart cards.

7. Provide an interface to request-to-exit switch within electrified door hardware for access-controlled doors. Provide request-to-exit motion sensor for access-controlled doors that do not contain integrated switch.

8. Provide door position switches for access controlled and monitored doors shown on project drawings.

9. Provide riser-rated composite cabling for access-controlled doors. Provide riser-rated device cabling for duress buttons and other alarm initiating devices not associated with a card reader.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. General

1. It shall be the Contractor's burden to prove that any manufacturer other than the ones listed for each product meets or exceed that section's requirements if submitted.

2. This specification is based on <MANUFACTURER NAME, SOFTWARE NAME AND VERSION NUMBER (i.e. Software House's C-CURE 9000 v2.40)> access control software - the most current appliance provided by <MANUFACTURER NAME> at the time of this specification's publication. Provide the latest release of electronic hardware and software at the time of installation. Using older versions of software and materials must be approved in writing by the Owner.

2.2 ACCESS CONTROL SOFTWARE

A. Application: Software that provides monitoring and management of access control panels, card readers, alarms and events, cardholder information, and allows integration with other security subsystems.

B. Access Control Software:

1. General:

a. Open architecture software platform that supports Microsoft Windows Server 2012 and 2016. Client component supports Microsoft Windows 10 operating systems for workstations.

b. Supports Active Directory, single sign-on, and capable of running on a Microsoft Windows Workgroup environment.

c. Capable of being installed in a virtual environment using industry-leading standards, such as VMware.

d. Software is hardware agnostic and supports commercial off-the-shelf servers (COTS) and storage attachments.

2. Interfaces:

a. Supports an unlimited number of card readers, inputs, and output points.

b. Supports elevator control.

c. Supports desktop and browser clients.

d. Supports IP, serial, and modem communications.

e. Supports mustering, anti-passback, and guard tour functions.

f. Supports integration with specified video management software (refer to Section 28 2300 - Video Surveillance System for additional requirements).

3. Features:

a. Supports fully customizable dynamic views for displaying system components, devices, and database information. Views display changes to the system in real-time.

b. Supports scalable and editable maps by importing vector and raster files to create complex floor plans that graphically illustrate the security system. Maps contain hyperlinks to other maps to create a hierarchy of interlinked files.

c. Supports secure database partitioning to allow for multiple independent entities to share a single database.

d. Supports intrusion zones and alarm/disarm commands through card readers with integrated keypads. Keypad commands can be configured to require a valid card read and/or valid PIN to activate the command.

e. Includes badge design software and smart card enrollment functionality.

C. Manufacturers:

1. Honeywell

a. #PW41CESW, “Pro-Watch Corporate” base server license for access control and badging software

b. #PW41SWCL, “Pro-Watch Corporate” add-on single-user client software license

c. #PW41BADGEL, “Pro-Watch Corporate” add-on single-user badging software license

d. #PW41RDRxxx (where “x” represents the model number to support the number of readers) add-on license for xx-readers

2. Lenel

a. #SWS-PROI, “OnGuard PRO-I” base server license for access control and badging software

b. #SWC-ADV, “OnGuard ADV/PRO” add-on single-user client software license

c. #SWC-IDPRO, “OnGuard PRO” add-on single-user badging software license

d. #PRO-64RUP, “OnGuard PRO” add-on license for 64-readers

3. S2 Security

   a. #S2-EX100-128, "Enterprise 100" appliance with 128 portal license

   b. #S2-IDC-128, "Identity Management" badge designer and print station license

4. Software House

   a. #CC9000-KIT-SQL, "C-CURE 9000" base server license

   b. #CC9000-Sxx (where "x" represents the selected software model number to support the number of readers and cardholders), "C-CURE 9000" add-on license for client and badging software, readers, and credentials

2.3 ACCESS CONTROL SERVERS

A. Application: Dedicated servers for access control software and associated Microsoft SQL database.

B. Document the cost of these devices at the time of bid due to advancements in technology. Prior to product order, provide upgrades to the latest model as recommended by the access control manufacturers up to the cost of the specified system.

C. Access Control Server:

   1. Processor: 1 x Intel Xeon E5-2640 v4 series

   2. Memory: 16GB RAM

   3. Hard drive configuration: RAID 1

   4. Hard drives: 2 x 1TB 7.2K

   5. OS: Windows Server 2012 (or most current version supported by the manufacturer)

   6. Network adapter: 2 x 1GbE

   7. Power supply: Redundant hot-swappable power supplies

D. Manufacturers:

   1. Dell

      a. #R430, "PowerEdge" rack-mounted server, 1U, 2 x 1TB, RAID 1

   2. Or equal

2.4 KVM CONSOLE

A. Application: LCD console with the integrated KVM switch in a rack-mount configuration.

B. KVM Console:

1. Display Type: 17” LCD 1280 x 1024, active-matrix color
2. Inputs: Keyboard, touchpad
3. KVM Connections: 16 x keyboard, video, monitor
4. Power: 100-240V auto-switching power supply
5. Size: 1U

C. Manufacturers:

1. APC
   a. #AP5816, 17” LCD rack console with an integrated 16-port KVM switch, 1U
   b. #AP5822, KVM USB patch cable, 3.0m
2. Or equal

2.5 UNINTERRUPTABLE POWER SUPPLY

A. Application: Provides high density, double-conversion on-line power protection with scalable runtime.

B. UPS:

1. Input Power: 208V
2. Input Power Connections: 1 x NEMA L6-30P
3. Output Power: 208V
4. Output Power Capacity: 4.25 KWatts (5 kVA)
5. Output Power Connections:
   a. 2 x NEMA L6-20R
   b. 2 x NEMA L6-30R
6. Battery Capacity: 840-ampere hour
7. Size: 5.1”H x 17”W, 3U
8. Finish: Black

C. Manufacturer:

1. APC

a. #SRT5KRMXLT, "Smart-UPS" series rack-mounted uninterruptable power supply, 5 kVA, 3U

2. Or equal

2.6 ACCESS CONTROL PANELS

A. Application: An intelligent controller with integrated battery backup, database, and communication ports that supports multiple card readers.

B. Features:

1. Supports multiple communication channels to which control panels, card readers, and alarm monitoring devices connect.

2. Supports hardware modules used for additional memory and/or future feature enhancements.

3. Supports flash upgrades for firmware updates.

4. On-board memory stores a minimum of 50,000 transactions.

5. Utilizes AES 128-bit data encryption for compliance with HSPD-12 and FIPS201 requirements.

6. Compliant with UL294 requirements.

7. Supports HID proximity, HID iCLASS SE, MIFARE, and DESFire card reader formats.

8. Supports up to 32 access levels per cardholder.

9. Supports redundant backup of configuration data.

10. Utilizes an onboard Ethernet NIC with DHCP support.

C. Manufacturer:

1. Honeywell

a. #PW6K1IC, "Intelligent Controller (IC)", control module, 32-interfaces (up to 64 readers)

b. #PW6KR1, interface module, 2-readers

c. #PW6K1IN, interface module, 16-inputs

d. #PW6K1OUT, interface module, 16-outputs

2. Lenel

a. #LNL-3300, "Intelligent System Controller (ISC)", 32-interfaces (up to 64 readers)

b. #LNL-1320, interface module, 2-readers

c. #LNL-1100, interface module, 16-inputs

d. #LNL-1200, interface module, 16-outputs

3. S2 Security

a. #S2-EP-2500, "Intelligent Controller (IC)", 32-interfaces (up to 64 readers)

b. #S2-MR-52, interface module, 2-readers

c. #S2-MR-16IN, interface module, 16-inputs

d. #S2-MR-16OUT, interface module, 16-outputs

4. Software House

a. #USTAR008, "iSTAR Ultra", 8-reader, access control panel and enclosure

b. #USTAR016, "iSTAR Ultra", 16-reader, access control panel and enclosure

c. #USTAR-ACM, "iSTAR Ultra", interface module, 8-readers

d. #USTAR-CAN, "iSTAR Ultra" enclosure for interface and "RM" modules

e. #AS0073-CSI, "RM" input bus module, 8-input configurable supervised inputs

f. #AS0074-000, "RM" output bus module", 8-outputs

2.7 ACCESS CONTROL ENCLOSURES

A. Application: Wall-mounted enclosures for security control panels and modules.

B. Enclosures:

1. Type: NEMA Type-1

2. Size: 30"W x 48"L x 6"D

3. Contains perforated back-panel for mounting control panels and modules.

4. Provide finger duct wireways within the enclosure to dress security cabling.

C. Manufacturer:

1. Unity

2. Hoffman

3. Or equal

2.8 ACCESS CONTROL POWER SUPPLIES

A. Application: Dedicated power supplies to support the electrified lock hardware and security devices.

B. Power Supplies:

1. Inputs:

a. Power Input: 120VAC 60Hz, 7 amp

b. Device Inputs: 16 normally open or open collector inputs

2. Outputs:

a. Power Output: 12VDC and/or 24VDC outputs

1) P/S 1 - 12VDC @ 5.5 amps, P/S 2 - 12VC @ 5.5 amps

2) P/S 1 - 12VDC @ 5.5 amps, P/S 2 - 24VDC @ 5.7 amps

3) P/S 1 - 24VDC @ 5.7 amps, P/S 2 - 24VDC @ 5.7 amps

b. Device Outputs: 16 auxiliary power outputs (outputs rated at 2 amp), thermal and short circuit protection with auto reset

3. Features:

a. UL listed fire alarm disconnect for any or all of the 16 inputs

b. AC fail supervision

c. Low battery and battery presence supervision

C. Batteries:

1. Sealed, non-spillable lead-acid battery with spaded terminals.

2. Output: 12VDC 12-ampere hour

D. Manufacturer:

1. Altronix

a. #MAXIMAL33D, “Maximal” series access power controller, 120VAC to 12/24VDC, 16 PTC outputs

b. #BT1212, 12VDC 12AH rechargeable batteries

2. Or equal

2.9 CARD PRINTER

A. Application: A robust, high-performance printing device capable of printing and laminating cards in a high volume.

B. Card Printer:

1. Print Method: HDP dye-sublimation, resin thermal transfer
2. Resolution: Up to 600 dpi
3. Speed: Up to 35 seconds per card with dual-side printing and lamination
4. Colors: Up to 16.7 million, 256 shades per pixel
5. Printing Options:
   a. Front: Full-color
   b. Back: Black-only
6. HDP Film: <Clear> or <Custom Holographic>
7. Over-laminate: Yes
8. Accepts card thickness from 0.009 inches to 0.050 inches
9. Includes 5 spare print ribbons, lamination ribbons, and cleaning rollers
10. Includes Ethernet NIC option

C. Manufacturer:

1. HID Global
   a. #93680, “Fargo HDP5600” series printer, dual-sided with dual-lamination
   b. #82601, “Fargo PolyGuard” clear over-laminate
   c. #84051, “Fargo YMCKK” print ribbon, dual-sided
   d. #84054, “Fargo HDP” holographic film
   e. #84053, “Fargo HDP” clear film
2. Or equal

2.10 CARD READERS

A. Application: Reader capable of supporting 125 kHz low-frequency and 13.56 MHz high-frequency formats.

B. Card Readers:

1. Rugged, weatherized polycarbonate enclosure, designed to withstand operating temperatures of -40° to 150° F (-40° to 65° C).

2. Utilizes a Wiegand protocol for communication to access control panels.

3. Utilizes custom site keys for increased security.

4. Utilizes a multi-color LED and an audible sounder to indicate door status.

5. Capable of reading the following formats:

a. 125 kHZ - HID proximity

b. 13.56 MHz - iCLASS SE (secure identity object)

C. Manufacturer:

1. HID Global

a. #910P, "multiCLASS SE RP15", series card reader, mullion mount

b. #920P, "multiCLASS SE RP40" series card reader, standard wall mount

c. #921P, "multiCLASS SE RPK40" series card reader with integrated keypad

2. Or equal

2.11 CARDS & CREDENTIALS

A. Application: Contactless smart card or key to providing versatile interoperability in applications such as access control, network logon security, cashless vending, time and attendance, event management, and biometric identification.

B. Credentials:

1. Card:

a. 13.56MHz read/write contactless smart card

b. Capable of direct image and thermal transfer with holograms, ultra-violet fluorescent inks, or other anti-counterfeiting features.

C. Manufacturer:

1. HID Global

a. #3400, "iCLASS SE" smart card

2. Or equal

2.12 POSITION SWITCHES

A. Application: Contact switches for use in access controlled and alarm monitored doors to provide door position functionality.

B. Door Position Switches:

1. Mounting: Recessed

2. Size: 1” diameter

3. Loop Type: Normally closed

4. Contacts: Single pole double throw

5. Gap Distance: Up to 0.5” in steel door applications

C. Manufacturer:

1. Interlogix

a. #1076, recessed door contact switch, 1” diameter

b. #2507A, surface mount wide gap switch with armored cable

2. Or equal

2.13 <CONFIRM IF REQUIRED> REQUEST TO EXIT SENSORS

A. Application: Passive infrared sensors for use in access-controlled doors where request-to-exit functionality is not integrated into electrified door hardware.

B. Request-To-Exit Sensor:

1. Power: 12 or 24VDC, 26mA

2. Alarm Output: Two form C relay contacts

3. Relay Latch: Adjustable relay latch time to 60 seconds

4. Timer: Programmable reset (accumulative) or non-reset (counting) modes

C. Manufacturer:

1. Bosch

a. #DS160i, request-to-exit passive infrared sensor, grey

b. #TP160, trim plate for request-to-exit sensor, grey

2. Or equal

2.14 WIRE & CABLE

A. Application: Horizontal security cabling to access controlled doors and alarm initiating devices.

B. Access Control System Cabling:

1. Composite Cabling:

a. Composite cabling for access-controlled doors consists of the following within a single PVC jacket:

1) Lock Power: 4C 18 AWG, shielded

2) Card Reader: 3TP 22 AWG, overall shielded

3) Door Contact: 2C 22 AWG, shielded

4) Request-to-Exit: 4C 22 AWG, shielded

b. UL tested and listed as CMP.

c. Cable installed indoors to contain a yellow jacket.

2. Device Cabling:

a. Cabling for duress buttons and other alarm initiating devices not associated with card reader-controlled doors will utilize a minimum of 18 AWG stranded conductors. Increase conductor size as required to allow for voltage drop on long runs.

b. UL tested and listed as CMP.

c. Cable installed indoors to contain a yellow jacket.

C. Manufacturer:

1. Superior Essex

a. #AC-A23-68, access control composite plenum rated cable, yellow

b. #2F-C15-44, 2C 18 AWG, shielded, yellow

c. #2F-C35-44, 4C 18 AWG, shielded, yellow

2. Or equal

PART 3 EXECUTION

3.1 EXAMINATION

A. Install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

B. Visit the site and verify that site conditions are in agreement with the design package. Report all changes to the site or conditions that will affect the performance of the system to the Owner in a report. The Contractor shall not take any corrective action without written permission from the Owner and Owner.

C. The Contractor shall perform a field survey, and furnish a report to the Owner as part of the site survey report. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Owner equipment.

D. Verify that all surfaces and areas are ready to receive work.

E. Verify field measurements as shown on drawings and as instructed by the manufacturer.

F. Verify that required utilities are available, in the proper location, and ready for use.

3.2 INSTALLATION

A. General:

1. Install the access control system-related equipment as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each device for conditions encountered at the site; connect signal lines and AC power to equipment interfaces.

2. Install the system in accordance with the manufacturer's recommendations. This includes, but is not limited to, the following:

   a. Wiring with racks shall be routed horizontally and vertically in neatly tied bundles. Point-to-point wiring shall not be used.

   b. Cable bundles shall cross from one rack to the next at the top, center, or bottom only, leaving sufficient working room within the rack.

   c. Wiring shall be tie-wrapped so that all connectors in a bundle can be removed and re-installed without the possibility of cross-connecting.

   d. Where wiring is routed through sheet metal or over frame members, the metal edges shall be covered with flexible grommeting or edge dressing (such as automobile door edge trim).

e. Double-sided foam tape shall not be used to secure any terminal boxes, relay bases or circuit boards, etc. All device mounting shall be of a permanent nature.

f. All excess length AC cords are to be tie-wrapped out of the way, and new plugs installed.

g. All cables shall be in conduit, present a professional appearance, and maintain the aesthetics of the installation area.

h. All cable shall be in conduit in exposed areas or in spaces without an accessible ceiling, present a professional appearance, and maintain the aesthetics of the installation area

i. Care shall be exercised at all times to protect Owner's property. For example, ladders shall not be placed against wallpapered or finished surfaces, equipment, or furnishings; desks or countertops shall not be used in lieu of ladders.

3. Provide all panel wiring required, including temporary wiring. Install wiring in accordance with NEC and NFPA regulations (as applicable), local building codes and ordinances, and all Owner wiring standards. The contractor shall be responsible for obtaining and adhering to applicable regulations, codes, ordinances, and standards. Label conductors at each end with legible, write-on type, self-laminating vinyl labels.

4. Ensure that:

a. All applicable statutes, ordinances, regulations, license requirements, and codes are fully complied with.

b. All required permits are obtained.

c. All required inspections are conducted.

d. All necessary certificates are issued, obtained, and delivered to the Owner.

e. All equipment installations and mounting are in strict accordance with requirements for applicable seismic classification.

B. Access Control Software:

1. Coordinate with Owner’s Security representatives to set the following criteria:

a. Access card levels and door groupings

b. Priority levels for alarm and events

c. Schedules and time zones

d. Holidays and holiday types

e. Actions and responses from individual alarm points

f. Routing of alarm points to operator's workstations

g. Custom reporting options

2. <CONFIRM IF REQUIRED> Integrate the access control software with the specified video management software to enable the following features:

a. Automatic camera call-up upon an event (i.e. door forced alarm, door held open too long, etc.) within the access control software to provide a single-user interfaced for responding to alarms.

b. View live and recorded video within the access control software.

c. Control PTZ cameras.

d. Time synchronization of events within the access control and video management software.

3. Incorporate building floor plans from architectural documents to develop dynamic maps complete with device icons and applicable text within the access control software.

a. Edit CAD or BIM drawing files so that non-applicable layers are removed so that the floor plans can be viewed in a simple manner.

b. Convert drawing files to a graphic format that is compatible with access control system software.

c. Utilize device icons on each graphical floor plan to indicate card readers, cameras, duress buttons, and other alarm points. Each icon provides the real-time status of the associated device with command and control functionality.

C. Access Control Panels:

1. Install access control panels and power supplies in the telecommunications rooms as indicated on project drawings.

2. Install resistors at device end of line (EOL) per manufacturer's instructions to provide four-state EOL supervision of devices and cabling.

D. Access Controlled Doors:

1. Card Readers:

a. Connect horizontal security cabling to card reader pigtail to enable the following functions:

1) Displays red LED when the door is locked and is in secure position.

2) Displays green LED when the door is unlocked.

3) Produces audible tone to indicate valid and invalid reads.

b. Utilize mounting plate to install card reader onto electrical back-box. Install plumb and square so that there are no obvious gaps between the wall surface and card reader.

2. Electrified Locks:

a. Terminate cabling from electrified door hardware onto designated output points of lock power supplies so that relays within the access control panels are thermally protected.

3. Door Position Switches:

a. Install recessed door contacts 6” from the leading edge of the door, unless otherwise noted.

4. Request-to-Exit Sensors:

a. Connect to electrified door hardware’s “RX” trigger wire for request-to-exit functionality. Install passive infrared request-to-exit motion sensors for doors that do not contain RX functionality within electrified door hardware.

b. Install motion sensor on the protected side of the door. Ensure that the detection beam is not obstructed by exit signs, fixtures, or other objects.

c. Adjust relay times and sensitivity on each door so that it properly detects valid exits and eliminates false alarms.

E. Enclosure Penetrations:

1. All enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involve transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.

F. Control Line Surge Protection:

1. Cables and conductors, except fiber optic cables, which serve as communication, control, or signal lines shall be protected against surges and shall have surge protection installed at each end.

2. Protection shall be provided at the equipment and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within three (3) feet of the building cable entrance.

3. Fuses shall not be used for surge suppression.

3.3 LABELING

A. General:

1. The Contractor shall generate all labeling (no labels will be furnished by the Owner) for access control system components. Components include, but are not limited to, the following:

a. Control panels, equipment enclosures, and power supplies

b. Conduits designated for security

c. Card readers and security devices

d. Wires and cables

e. Terminal blocks and relays

2. Labels shall coincide with identifications used on contractor-generated as-built drawings.

3. Labels utilized shall be of sufficient size and have an adhesive backing for permanent attachment.

B. Device Labeling:

1. Coordinate with Owner's Security representative for device label format.

2. Labeling of security devices shall match labeling of device icons within access control system software.

C. Cable Labeling:

1. Utilize permanent machine-generated labels for security cabling with applicable font and text size so that it can be easily legible.

2. Position labels so that they are visible without the need to remove obstructions such as wire management or other materials.

3. Label security cabling at both ends (device and control panel).

3.4 TESTING

A. General:

1. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Written permission shall be obtained from the Owner before proceeding with the next phase of testing. Original copies of all data produced during performance

verification shall be turned over to the Owner at the conclusion of each phase of testing prior to the Owner's approval of the test.

2. Coordinate testing requirements with the General Contractor and provide specific information on pre-acceptance and final acceptance testing activities so that they can be entered into the overall construction schedule.

B. Cable Testing:

1. All cables and termination hardware shall be 100% tested for defects in the installation and the materials used in order to verify performance under installed conditions. All conductors of each installed cable and system component shall be verified usable by the contractor.

2. All cables shall be tested in accordance with this document, and the best industry-standard practices. If any of these are in conflict, the Contractor shall be responsible to bring any discrepancies to the attention of the designer for clarification and/or resolution.

   a. All cables shall be tested for acceptable signal strength and passage.

   b. All test results shall be well documented and the documentation given to the designer for proper distribution.

3. The access control cabling system shall be tested by using an approved test unit capable of performing the required tests.

C. Pre-Acceptance Testing:

1. The Contractor shall perform a 100% pre-acceptance test to verify the operation of the access control system prior to the final acceptance test with the Owner.

2. Pre-Acceptance Testing activities shall not occur until the Contractor has ensured that all punch list items have been remedied. If conditions exist that may cause degradation or interference with any security device, the Contractor shall inform the Owner.

3. The pre-acceptance testing shall, as a minimum, include:

   a. Verification that any signal or control cabling has been installed, tested and approved as specified.

   b. Verification that electrified door hardware functions properly on access-controlled doors. Coordinate testing with door hardware contractor.

   c. Verification that card readers, position switches, and request-to-exit sensors have been properly installed to provide: valid card reads, invalid card reads, door forced open, and the door propped alarms.

d. Verification that access control software has been properly programmed per the Owner's instructions and configured to integrate third-party databases.

e. Verify integration with the specified video surveillance system for automatic camera call-up on alarm with proper alarm/event recording parameters.

4. Document the results of the pre-acceptance testing using approved test forms. The report shall indicate the system has been properly calibrated, tested, and is ready to begin final acceptance testing with the Owner.

D. Acceptance Testing

1. Upon successful completion of Pre-Acceptance Testing, the Contractor shall demonstrate to the Owner that the completed access control system complies with the contractor's requirements. Acceptance Testing shall not commence until receipt of approved Pre-Acceptance Testing activities based on the Contractor's written report.

2. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown.

3. The Owner may terminate Acceptance Testing at any time when the system fails to perform as specified. Upon termination of testing by the Owner or by the Contractor, the Contractor shall submit a report outlining the required repairs to the Owner then commence system repairs upon direction by the Owner. Upon successful completion of the Acceptance Testing, the Contractor shall deliver test reports and other documentation as specified to the Owner.

3.5 TRAINING

A. Training shall be supplied as part of the Contractors work. Specifically, an authorized individual familiar with the access control system and related subsystems as specified herein shall conduct the training.

B. Training shall provide information regarding the operation of the systems, diagnostics, as well as any other aspects required to provide a knowledge base to manage the access control system.

C. <CONFIRM TRAINING REQUIREMENTS> The Contractor shall coordinate four (4) separate training sessions at least two (2) weeks prior to system turnover for a class of no more than eight (8) people. Classes shall be coordinated to include all shifts for all operators. If required, classes will be split up to accommodate the Owner.

1. Session 1:

a. A half-day session-oriented towards familiarizing operators with basic commands of the access control client software.

2. Session 2:

a. An all-day session detailing system administration that shall include, but is not be limited to, replacing system diagnostics, changing panel configurations, creating new access levels and time zones, adding/deleting cardholders, troubleshooting, as well as any other item necessary to manage the access control system.

3. Session 3:

a. Performed one week prior to system turnover and shall be an all-day session that shall cover system administration and basic operator training as described in Sessions 1 and 2.

4. Session 4

a. The last and final training session shall be an all-day session that shall recap all administration, basic operator commands and shall be completed post-occupancy at a time coordinated with the Owner. This session shall cover both administration and basic operator commands and also allows the Owner to comment on the performance of the system.

END OF SECTION

SECTION 28 21 00
VIDEO SURVEILLANCE SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Network video cameras:

a. Fixed dome cameras

b. Panoramic cameras: single sensor, multi-sensor, and multi-directional

c. Pan-tilt-zoom (PTZ) cameras

2. Mounts, housings, and accessories

3. Surge protection devices

B. Related Sections:

1. Section 27 15 13: Communications Horizontal Copper Cabling

2. Section 27 32 26: Emergency Phone System

3. Section 28 23 00: Video Management System

1.2 SUBMITTALS

A. Comply with the submittal procedures of Section 28 05 00: Common Work Results for Electronic Safety and Security Systems.

B. Submittal requirements:

1. Product Data Brochures

2. Shop Drawings

3. Record Drawings

1.3 SYSTEM DESCRIPTION

A. General:

1. The intent of this document is to provide all pertinent information to allow the contractor to bid the labor, supervision, tooling, and miscellaneous consumables to provide a complete video surveillance system. It is the responsibility of the contractor to include any and all items required for a complete system if not identified in these specifications or drawings.

B. Overview:

1. Cameras will be served by Owner provided network switches in the TDRs and utilize the Owner's LAN for connectivity to network video recording. Refer to Section 28 23 00: Video Management System for software and network recording parameters.

2. Cabling for the network cameras will be provided under Section 27 15 13: Communications Horizontal Copper Cabling.

C. Scope of Work:

1. Provide 180-degree panoramic multi-sensor cameras on the exterior of the building.

2. Provide network fixed and 360-degree single-sensor panoramic cameras as shown on project drawings in interior spaces. Cameras installed within interior ceilings to contain a recessed ceiling housing,

3. Provide camera surge protectors for exterior cameras. Include suppression and grounding equipment to protect head-end devices as required.

D. Integration with the Emergency Phone System:

1. Provide 360-degree panoramic multi-directional multi-sensor cameras on the blue-light emergency phone towers located on the site and surface parking areas.

2. Refer to Section 27 32 26: Emergency Phone System for product type and additional requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. It shall be the Contractor's burden to prove that any manufacturer other than the ones listed for each product meets or exceed that section's requirements if submitted.

B. Manufacturers:

1. Axis Communications

2. Or equal

2.2 NETWORK FIXED DOME CAMERAS – 1080P

A. Description: Fixed IP-cameras capable of providing an HDTV 1080p resolution in a mini-dome housing.

B. Camera:

1. Image sensor: Progressive scan CMOS 1/2.8" sensor

2. Lens: Varifocal 3.4-8.9 mm F1.8, remote focus and zoom, IR corrected, P-Iris control

3. Day/Night: Automatic, removable infrared-cut filter
4. Illumination: Color 0.1 lux F1.8, B/W 0.02 lux F1.4
5. Dynamic Range: Equivalent to 120 dB
6. Shutter Speed: 1/66,500 s to 2 s
7. Horizontal Viewing Angle: 100° to 36°
8. Vertical Viewing Angle: 53° to 20°

C. Video:

1. Video compression: H.265 main profile; H.264 high, main, and baseline profile
2. Resolution: 1920x1080 to 160x90
3. Frame rate:
   a. 60 fps in 1920x1080 without WDR
   b. 30 fps in 1920x1080 with WDR
4. Streaming: Multiple, individually configurable streams in H.264 and H.265 with controllable frame rate and bandwidth.
5. Settings: Wide dynamic range (WDR), remote back focus, remote zoom, backlight compensation, compression, color, contrast, white balance, exposure control

D. Network:

1. Security: password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware, secure boot
2. Supported protocols: IPv4 and IPv6, HTTP and HTTPS, SSL/TLS
3. Application platform: ONVIF profiles G, S, and T; support for SIP integration with VoIP systems through peer-to-peer or integrated with SIP/PBX

E. Interface:

1. Network Port: RJ-45, 100BASE-TX
2. Card Slot: microSD x 1

F. General:

1. Interior Model:

a. Casing: IP52 rated, IK-10 impact-resistant, polycarbonate casing with hard-coated dome and dehumidifying membrane

b. Power: PoE IEEE 802.3af/802.3at Type 1 Class 2, typical 3.5 W, max 5.7 W

c. Utilizes a recessed ceiling mount kit for installation within an acoustical ceiling tile or finished ceiling

2. Exterior Model:

a. Casing: IP66 and NEMA 4X rated, IK-10 impact-resistant, polycarbonate casing with hard-coated dome and dehumidifying membrane

b. Power: PoE 802.3af/802.3at Type 1 Class 3, typical 3.5 W, max 8 W

c. Utilizes a pendant and bracket kit for installation on an exterior wall

d. Utilizes a pendant, bracket, pole mount adapter, and stainless-steel straps for installation on exterior light poles

G. Manufacturer:

1. Axis Communications

a. Interior Ceiling:

1) #01591-001, “P3245-V” mini-dome camera, 1080p, interior model

2) #01757-001, “TP3201” recessed ceiling mount for interior ceilings

b. Exterior Soffit:

1) #01594-001, “P3245-VE” mini-dome camera, 1080p, exterior model

2) #01156-001, "T94M02L" recessed ceiling mount for exterior soffits

c. Exterior Wall:

1) #01594-001, “P3245-VE” mini-dome camera, 1080p, exterior model

2) #5505-871, "T94T01D" pendant kit

3) #5506-481, "T91E61" wall-mount bracket

d. Exterior/Site Pole:

1) #01594-001, “P3245-VE” mini-dome camera, 1080p, exterior model

2) #5505-871, "T94T01D" pendant kit

3) #5506-481, "T91E61" wall-mount bracket

4) #5504-581, "T91A47" pole-mount adaptor and straps

e. Exterior/Garage Ceiling:

1) #01594-001, “P3245-VE” mini-dome camera, 1080p, exterior model

2) #5505-871, "T94T01D" pendant kit

3) #5507-451, "T91B50" telescopic ceiling mount

2. Or equal

2.3 NETWORK PANORAMIC CAMERAS – SINGLE-SENSOR, 360°, 6 MP

A. Description: Panoramic camera capable of providing a 360° overview and dewarped quad views in an indoor environment.

B. Camera:

1. Image sensor: Progressive scan CMOS 1/1.8” sensor

2. Lens: Fixed iris 1.56 mm F2.0, fixed iris, IR corrected

3. Day/Night: Automatic, removable infrared-cut filter

4. Illumination: Color 0.16 lux F2.0, B/W 0.03 lux F2.0

5. Dynamic Range: Equivalent to 120 dB

6. Shutter Speed: 1/16,000 s to 1 s

7. Horizontal Viewing Angle: 183°

8. Vertical Viewing Angle: 183°

C. Video:

1. Video compression: H.265 main profile; H.264 high, main, and baseline profile

2. Resolution:

a. Overview: 2016x2016 to 160x160

b. Panorama: 2560x1440 to 192x72

c. Double Panorama: 2560x1920 to 384x288

d. Quad View: 2560x1920 to 384x288

3. Frame rate:

a. 60 fps in 360° overview only, up to 2016x2016 without WDR

b. 30 fps in 360° overview and 4 x dewarped views with WDR

4. Streaming: Multiple, individually configurable streams in H.264 and H.265 with controllable frame rate and bandwidth.

5. Settings: Wide dynamic range (WDR), remote back focus, remote zoom, backlight compensation, compression, color, contrast, white balance, exposure control

D. Network:

1. Security: password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware, secure boot

2. Supported protocols: IPv4 and IPv6, HTTP and HTTPS, SSL/TLS

3. Application platform: ONVIF profiles G, S, and T; support for SIP integration with VoIP systems through peer-to-peer or integrated with SIP/PBX

E. Interface:

1. Network Port: RJ-45, 100BASE-TX

2. Card Slot: microSD x 1

F. General:

1. Casing: polycarbonate and aluminum casing

2. Power: PoE IEEE 802.3af/802.3at Type 1 Class 3, typical 8.0 W, max 11.9 W

3. Utilizes a recessed ceiling mount kit for installation within an acoustical ceiling tile or finished ceiling

G. Manufacturer:

1. Axis Communications

a. Interior Ceiling:

1) #02109-001, “M3057-PLVE Mk II” single-sensor panoramic camera, 6 MP

2) #01462-001, “T94S02L” recessed ceiling mount for M30 series cameras

2. Or equal

2.4 NETWORK PANORAMIC CAMERAS – MULTI-SENSOR, 180°, 8 MP

A. Description: Multi-sensor panoramic camera capable of providing a seamless 180° view with 4 x 1080p camera sensors and varifocal lenses.

B. Camera:

1. Image sensor: Progressive scan 4 X CMOS 1/2.8” sensor, 1080p

2. Lens: Fixed 3.2 F2.0, remote focus, IR corrected

3. Day/Night: Automatic, removable IR cut filter

4. Illumination: Color 0.17 lux F2.0, B/W 0.04 lux F2.0

5. Shutter Speed: 1/33,500 s to 1/10 s

6. Panoramic Viewing Angle: 180°

C. Video:

1. Video compression: H.265, H.264 high, main, and baseline profile

2. Resolution: 4 x (1920x1080)

3. Frame rate:

   a. 4 x (30 fps in 1920x1080) without WDR when client software dewarps 180° view

   b. 4 x (15 fps in 1920x1080) with WDR when client software dewarps 180° view

4. Streaming: Multiple, individually configurable streams in H.264 with controllable frame rate and bandwidth.

5. Settings: Wide dynamic range (WDR), remote back focus, remote zoom, backlight compensation, compression, color, contrast, white balance, exposure control

D. Network:

1. Security: password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware, secure boot

2. Supported protocols: IPv4 and IPv6, HTTP and HTTPS, SSL/TLS

3. Application platform: ONVIF profiles G, S, and T; support for SIP integration with VoIP systems through peer-to-peer or integrated with SIP/PBX

E. Interface:

1. Network Port: RJ-45, 1000BASE-TX

2. Card Slot: microSD x 2

F. General:

1. Casing: IP66 and NEMA 4X rated, IK-10 impact-resistant, polycarbonate
2. Power: PoE IEEE 802.3af/802.3at Type 2 Class 4, typical 7 W, max 12.9 W
3. Utilizes a pendant and bracket kit for installation on an exterior wall
4. Utilizes a pendant, bracket, pole mount adapter, and stainless-steel straps for installation on exterior light poles

G. Manufacturers:

1. Axis Communications
   a. Exterior Wall Mount
      1) #01048-001, “P3807-PVE” multi-sensor panoramic camera, 8 MP
      2) #01505-001, “T94V02D” pendant kit
      3) #5504-821 “T91D61” wall-mount kit
   b. Exterior/Site Pole:
      1) #01048-001, “P3807-PVE” multi-sensor panoramic camera, 8 MP
      2) #01505-001, “T94V02D” pendant kit
      3) #5504-821 “T91D61” wall-mount kit
      4) #01164-001, "T91B47" pole-mount adaptor and straps
2. Or equal

2.5 NETWORK PANORAMIC CAMERAS – MULTI-DIRECTIONAL, 360°, 15 MP

A. Description: Multi-sensor and a multi-directional panoramic camera capable of providing a 360° view with 4 x QHD (1440p) camera sensors and varifocal lenses.

B. Camera:

1. Image sensor: Progressive scan 4 X CMOS 1/2.5” sensor, 1440p
2. Lens: Varifocal 3.0 – 6.0mm F1.8-2.6, remote focus and zoom, IR corrected, P-Iris control, megapixel resolution
3. Day/Night: Automatic, removable IR cut filter
4. Illumination: Color 0.20 lux F1.8, B/W 0.04 lux F1.8 (0.00 lux with IR LED on)
5. Shutter Speed: 1/66,500s to 1/5 s
6. Horizontal Viewing Angle: 101-49°

7. Vertical Viewing Angle: 54-29°

8. Diagonal Viewing Angle: 116-58°

C. Video:

1. Video compression: H.264 high, main, and baseline profile

2. Resolution: 4 x 2560x1440 (4 x QHD 1440p capture mode) to 160x90

3. Frame rate: 30 fps in 4x1440p capture mode

4. Streaming: Multiple, individually configurable streams in H.264 with controllable frame rate and bandwidth.

5. Settings: Wide dynamic range (WDR), remote back focus, remote zoom, backlight compensation, compression, color, contrast, white balance, exposure control.

D. Network:

1. Security: password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware, secure boot

2. Supported protocols: IPv4 and IPv6, HTTP and HTTPS, SSL/TLS

3. Application platform: ONVIF profiles G, S, and T; support for SIP integration with VoIP systems through peer-to-peer or integrated with SIP/PBX

E. Interface:

1. Network Port: RJ-45, 1000BASE-TX

2. Card Slot: microSD x 2

F. General:

1. Casing: IP66 and NEMA 4X rated, IK-09 impact-resistant, polycarbonate

2. Power: PoE IEEE 802.3at Type 2 Class 4, typical 16.3, max 25.5 W

3. Utilizes a pendant and bracket kit for installation on an exterior wall

4. Utilizes a pendant, bracket, pole mount adapter, and stainless-steel straps for installation on exterior light poles

G. Manufacturers:

1. Axis Communications

a. Exterior/Site Pole:

1) #01500-001, “P3719-PLE” multi-directional panoramic camera, 15 MP

2) #01513-001, “T94N01D” pendant kit

3) #5504-821 “T91D61” wall-mount kit

4) #01164-001, "T91B47" pole-mount adaptor and straps

2. Or equal

2.6 NETWORK PTZ CAMERAS

A. Application: Pan-tilt-zoom IP-cameras capable of providing UHD 4K video resolution in an exterior pendant dome housing.

B. Camera:

1. Image sensor: Progressive scan CMOS 1/2.5” sensor, UHD 4K

2. Lens: 4.4 – 88.4mm f2.0 - 3.8, 36x zoom

3. Day/Night: Automatic, removable IR cut filter

4. Illumination: Color 0.20 lux F2.0, B/W 0.002 lux F2.0

5. Dynamic Range: Equivalent to 120 dB

6. Shutter Speed: 1/10,000s to 1 s

7. Horizontal Viewing Angle: 68.3-4.2°

8. Vertical Viewing Angle: 42.1-2.34°

C. Video:

1. Video compression: H.265 main profile; H.264 high, main, and baseline profile

2. Resolution: 3840x2160 to 320x180

3. Frame rate:

a. 30 fps in 3840x2160 UHD 4K

b. 60 fps in 1920x1080 with WDR

4. Streaming: Multiple, individually configurable streams in H.264 and H.265 with controllable frame rate and bandwidth.

5. Settings: Wide dynamic range (WDR), remote back focus, remote zoom, backlight compensation, compression, color, contrast, white balance, exposure control

D. Network:

1. Security: password protection, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware, secure boot

2. Supported protocols: IPv4 and IPv6, HTTP and HTTPS, SSL/TLS

3. Application platform: ONVIF profiles G, S, and T; support for SIP integration with VoIP systems through peer-to-peer or integrated with SIP/PBX

E. Interface:

1. Network Port: RJ-45, 100BASE-TX

2. Card Slot: microSD x 1

F. General:

1. Casing: IP66 and NEMA 4X rated, IK-10 impact-resistant, polycarbonate

2. Power:

a. High PoE 60 W SFP midspan: 100-240 VAC, max 66.1W

b. Camera consumption: typical 16 W, max 51 W

3. Utilizes a pendant and bracket kit for installation on an exterior wall

4. Utilizes a pendant, bracket, pole mount adapter, and stainless-steel straps for installation on exterior light poles.

G. Manufacturers:

1. Axis Communications

a. Exterior Wall:

1) #02148-004, “Q6078-E” pan-tilt-zoom camera, UHD 4K

2) #5502-431, “T94A01D” pendant kit

3) #5504-821 “T91D61” wall-mount kit

b. Exterior/Roof Parapet

1) #02148-004, “Q6078-E” pan-tilt-zoom camera, UHD 4K

2) #5502-431, “T94A01D” pendant kit

3) #5507-271, “T91D62” telescopic parapet mount

4) #5505-381, “T98A18-VE” media converter cabinet

c. Exterior/Site Pole:

1) #02148-004, “Q6078-E” pan-tilt-zoom camera, UHD 4K

2) #5502-431, “T94A01D” pendant kit

3) #5504-821 “T91D61” wall-mount kit

4) #01164-001, "T91B47" pole-mount adaptor and straps

5) #5505-381, “T98A18-VE” media converter cabinet

2. Or equal

2.7 CAMERA SURGE PROTECTION DEVICES

A. Application: Protects circuits and devices that use PoE connections.

B. Features:

1. Protects power, video, and data on network-based security cameras.

2. Supports GbE without signal degradation.

3. Compliant with IEEE 802.3af and 802.3at for PoE and High PoE

C. General:

1. Connectors: RJ45 connection with external grounding screw

2. Data rate: Gigabit Ethernet

3. Max Continuous Current: 1.5 Amps

4. Dissipation: 3,000 W

5. Protection Mode: Line-Ground

D. Manufacturers:

1. Ditek

a. #DTK-MRJPOE, a surge protection device for PoE devices

2. Or equal

PART 3 EXECUTION

3.1 EXAMINATION

A. Install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and as shown, and shall furnish all

necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

B. Visit the site and verify that site conditions are in agreement with the design package. Report all changes to the site or conditions that will affect the performance of the system to the Owner in a report. The Contractor shall not take any corrective action without written permission from the Owner and Owner.

C. The Contractor shall perform a field survey and furnish a report to the Owner as part of the site survey report. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Owner equipment.

D. Verify that all surfaces and areas are ready to receive work.

E. Verify field measurements as shown on drawings and as instructed by the manufacturer.

F. Verify that required utilities are available, in the proper location, and ready for use.

3.2 INSTALLATION

A. General:

1. Install the video surveillance cameras and related equipment as specified by the manufacturer and as shown. Provide mounting hardware sized appropriately to secure each device for conditions encountered at the site.

B. Network Cameras:

1. Provide flush ceiling mount kit for fixed network cameras within interior accessible ceiling space. Install camera body above ceiling line so only lower polycarbonate dome and the trim ring is exposed.

2. Provide outdoor-rated housings and mounts for exterior cameras.

3. Prior to installation, coordinate with an electrical contractor to confirm the exact placement of cameras for conduit and rough-in requirements.

4. Field determine the exact placement of cameras installed in the interior accessible ceiling to ensure complete coverage of the targeted area.

5. Adjust the wide dynamic range, gain control, and noise reduction settings on each camera as required to provide clear and crisp video images.

C. Camera Surge Protection:

1. Connect incoming horizontal UTP cabling in the IN connector. Connect the camera's UTP patch cable to the OUT connector to be protected.

2. Use common ground per device to eliminate the possibility of a differential in ground potentials.

3.3 TESTING

A. General:

1. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Written permission shall be obtained from the Owner before proceeding with the next phase of testing. Original copies of all data produced during performance verification shall be turned over to the Owner at the conclusion of each phase of testing prior to Owner's approval of the test.

2. Coordinate testing requirements with the General Contractor and provide specific information on pre-acceptance and final acceptance testing activities so that they can be entered into the overall construction schedule.

B. Cable Testing:

1. All cables and termination hardware shall be 100% tested for defects in the installation and the materials used in order to verify performance under installed conditions. All conductors of each installed cable and system component shall be verified usable by the contractor.

2. Testing for the horizontal structured cabling serving the video surveillance system provided by under Section 27 15 13: Communications Horizontal Copper Cabling.

END OF SECTION

SECTION 28 23 00
VIDEO MANAGEMENT SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Video management software and camera licenses
2. Network video recorder servers and storage arrays
3. Integration with the access control system

B. Related Sections:

1. Section 28 13 00: Access Control System
2. Section 28 21 00: Video Surveillance Cameras

1.2 SUBMITTALS

A. Comply with the submittal procedures of Section 28 05 00: Common Work Results for Electronic Safety and Security Systems.

B. Submittal requirements:

1. Product Data Brochures
2. Shop Drawings
3. Video Storage and Hardware Calculations:
   a. Include system descriptions, analyses, and calculations used in sizing equipment specified. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification.
   b. The calculations shall identify:
      1) Camera model
      2) Quantity
      3) Communication protocol (ONVIF, PSIA, etc.)
      4) Compression format (MJPEG, MPEG4, or H.264)
      5) Resolution
      6) Frames per Second

7) Bitrate

8) Percentage of motion (if not required to be continuous)

9) Number of days to record (minimum of 30)

10) Storage requirement

11) Server requirement

12) Estimated bandwidth

13) Estimated capacity to support future cameras

4. Record Drawings

1.3 SYSTEM DESCRIPTION

A. General:

1. The intent of this document is to provide all pertinent information to allow the contractor to bid the labor, supervision, tooling, and miscellaneous consumables to provide a complete video surveillance system. It is the responsibility of the contractor to include any and all items required for a complete system if not identified in these specifications or drawings.

B. Scope of Work:

1. Provide video management software with associated license fees to support the number of cameras and security devices shown on the project drawings.

2. Provide client software licenses, if required, at security monitoring workstations shown on the project drawings.

3. Provide network video recording (NVR) servers with the following parameters:

a. 1 fps continuous recording at 1920 x 1080 resolution

b. 30 fps event recording at 1920 x 1080 resolution (assume 30 % motion activity)

c. 30 days of video storage

C. Integration with the Access Control System:

1. Provide software integration licenses to integrate the video management software with the specified access control system (refer to Section 28 13 00: Access Control System for additional requirements) to enable the following features:

a. Automatic camera call-up upon an event (i.e. door forced alarm, door held open too long, etc.) within the access control software to provide a single user interface for responding to alarms.

b. View live and recorded video within the access control software.

c. Time synchronization of events within the access control and video management software.

D. Integration with the Security Intercom System:

1. Provide video management software license fees to support recording of the cameras within the video intercom stations shown on the project drawings.

2. Refer to Section 28 15 23: Security Intercom System for product type and additional requirements.

PART 2 PROVIDE SOFTWARE PRODUCTS

2.1 VIDEO MANAGEMENT SOFTWARE

A. Application: Software-that provides remote video monitoring, recording, and event management functionality.

B. General:

1. Open architecture software platform that supports Microsoft Windows Server. The client component supports Microsoft Windows 10 operating systems for workstations.

2. Supports Active Directory, single sign-on, and capable of running on a Microsoft Windows Workgroup environment.

3. Capable of being installed in a virtual environment using industry-leading standards, such as VMware.

4. Software is hardware agnostic and supports commercial off-the-shelf servers (COTS) and storage attachments.

C. Configuration:

1. Deployment Type: Multi-server, centrally managed

2. Software Licensing: Perpetual

3. Max # of cameras per NVR: Unrestricted

4. Max # of NVRs per system: Unrestricted

5. Max # of concurrent users: Unrestricted

D. Interfaces:

1. Supports network cameras using the ONVIF communication protocol and from multiple third-party manufacturers using H.265, H.264, MPEG-4, and MJPEG video compression.

2. Supports desktop, browser, and mobile web clients. Capable of pushing live video-on-demand to and from any client.

3. Supports unicast and multicast video streaming.

4. Supports native motion detection that can be executed at the edge device (encoder or network camera).

5. Supports dewarping of recorded video from panoramic or fisheye cameras.

6. Supports multi-channel audio recording.

E. Video Recording:

1. Capable of performing multiple tasks simultaneously, and within practical limits, no task shall interfere with any other task.

2. Supports continuous recording, scheduled recording, and event-based recording (motion, alarms, video analytics, etc.) with the ability to augment the video recording parameters per camera upon such events.

3. Capable of performing the following tasks simultaneously:

a. Digitizing and compressing video and calculating digital signatures for video authentication.

b. Writing video to files on local hard disks and maintaining an accurate index of the stored video files.

c. Deleting older video files as needed, freeing up space to record newer video files.

d. Selectively transferring recorded video to long-term storage media.

F. Features:

1. Supports dynamic maps with hyperlinks to other maps to create a hierarchy of interlinked files.

2. Includes hardware and bandwidth utilization for monitoring and recording video at different frame rates and resolutions.

3. Supports single and bulk device firmware updates.

4. Provides audit trails of activities and actions performed in the system.

5. Supports multiple configurable windows supporting the following simultaneous functions:

a. Viewing live and recorded video within multiple windows

b. PTZ camera control

c. Export video to digital media devices (CD, etc.)

d. Time synchronized playback

e. Sequential views of predefined areas (guard tours)

6. Supports up to 4 monitors per client workstation. Each monitor can be individually configured to allow users to open, move, and size multiple video windows. Monitor layouts can be saved by operator logon.

7. Capable of restricting individual functions within client software by operator level.

G. Advanced search capabilities (via additional modules):

1. Unusual motion/activity detection

2. Intelligent motion search

3. Auto-generated time intervals with thumbnail image previews

4. Object or zone-based search

5. Alarm event via an access control system or video analytic behaviors

6. Appearance search

7. License plate event search

H. Manufacturers:

1. Milestone

a. #XPP-PLUS-BL, “XProtect Professional+” base license

b. #XPP-PLUS-DL, “XProtect Professional+” single device license

2. Or equal

2.2 NETWORK VIDEO RECORDER (NVR) SERVERS

A. Application: Dedicated servers for network video recording.

B. Document the cost of these devices at the time of bid due to advancements in technology. Prior to product order, provide upgrades to the latest model as recommended by the video management software manufacturer up to the cost of the specified system

C. Network Video Recording Server:

1. Processor: Intel Xeon

2. Memory: 32GB (2 x 16GB) DDR4

3. OS: Windows Server 2019 (or most current version supported by the manufacturer)

4. OS hard drive configuration: RAID 1

5. OS hard drives: 2 x M.2 SSD drives

6. Recording hard drive configuration: RAID 6

7. Recording hard drives: Supports up to 192 TB raw, 162 TB effective (12 x 16 TB drives)

8. Network adapter: 4 x 1GbE

9. Power supply: Redundant hot-swappable power supplies

10. Manufacturers:

    a. Milestone

        1) #HE1800R-xxxTB, "Husky IVO 1800" series NVR where "xxx" represents the total number of hard drive storage based on the specified recording parameters

        2) #HA-RR-740, PEC static rack rail kit for Husky 1800R NVR

    b. Or equal

PART 3 EXECUTION

3.1 EXAMINATION

A. Install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

B. Visit the site and verify that site conditions are in agreement with the design package. Report all changes to the site or conditions that will affect the performance of the system to the Owner in a report. The Contractor shall not take any corrective action without written permission from the Owner and Owner.

C. The Contractor shall perform a field survey and furnish a report to the Owner as part of the site survey report. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Owner equipment.

D. Verify that all surfaces and areas are ready to receive work.

E. Verify field measurements as shown on drawings and as instructed by the manufacturer.

F. Verify that required utilities are available, in the proper location, and ready for use.

3.2 PREPARATION

A. Review configurable features of the VMS with the Owner's Representative and document the results of the meeting in the Project planning documents. The following configuration topics shall be resolved prior to configure equipment and services:

1. Internet Service Provider, firewall, and IP schema for VMS devices.

2. Time server synchronization scheme for overall security system.

3. Plan for system testing, startup, and demonstration.

4. Acceptance test concept and, on approval, develop specifics of the test.

5. List of default user IDs and passwords (factory defaults) for VMS applications, servers, and workstations.

6. Prepare root certificates and necessary child certificates for a secure connection between system components.

3.3 INSTALLATION

A. Video Management Software:

1. Coordinate with Owner's IT and Security representatives to set the following criteria:

a. Administrator and operator passwords

b. Camera and video device nomenclature

c. Maximum bitrate (assume 4-6MB per camera) and bandwidth throttle, if any

d. Camera groups, salvos, and operator views

e. PTZ camera presets

f. Mapping features and criteria for a fully interactive graphical display of each floor plan

g. Alarm events and integration into the access control system

2. Comply with manufacturer's written data, including product technical bulletins, product catalog installation instructions, and product carton installation instructions.

3. All firmware in products shall be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the VMS to ensure approved integration compatibility.

B. NVR Servers:

1. Coordinate with Owner's IT and Security representatives to properly rack-mount the NVR server.

2. When applicable, connect keyboard, video, and mouse cables to KVM switch within rack-mounted LCD console.

3.4 TESTING

A. Pre-Acceptance Testing:

1. The Contractor shall perform a 100% pre-acceptance test to verify the operation of the video management system prior to the final acceptance test with the Owner.

2. Pre-Acceptance Testing activities shall not occur until the Contractor has ensured that all punch list items have been remedied. If conditions exist that may cause degradation or interference with any security device, the Contractor shall inform the Owner.

3. The pre-acceptance testing shall, as a minimum, include:

   a. Verification that any signal or control cabling has been installed, tested and approved as specified.

   b. Verify that cameras are properly installed and provide clear, crisp images in the specified format and resolution.

   c. Verification that the current recording configuration provides the minimum required storage (i.e. 30 days, etc.).

   d. Verification that client software is able to view live video and recorded video. Verify graphical mapping and alarm management screens.

   e. Verify integration with specified access control system for automatic camera call-up on alarm with proper alarm/event recording parameters.

4. Document the results of the pre-acceptance testing using approved test forms. The report shall indicate the system has been properly calibrated, tested, and is ready to begin final acceptance testing with the Owner.

B. Acceptance Testing

1. Upon successful completion of Pre-Acceptance Testing, the Contractor shall demonstrate to the Owner that the completed video surveillance system complies with the contractor's requirements. Acceptance Testing shall not commence until receipt of approved Pre-Acceptance Testing activities based on the Contractor's written report.

2. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown.

3. The Owner may terminate Acceptance Testing at any time when the system fails to perform as specified. Upon termination of testing by the Owner or by the Contractor, the Contractor shall submit a report outlining the required repairs to the Owner then commence system repairs upon direction by the Owner. Upon successful completion of the Acceptance Testing, the Contractor shall deliver test reports and other documentation as specified to the Owner.

3.5 TRAINING

A. Training shall be supplied as part of the Contractors work. Specifically, an authorized individual familiar with the video surveillance system and related subsystems as specified herein shall conduct the training.

B. Training shall provide information regarding the operation of the systems, diagnostics, as well as any other aspects required to provide a knowledge base to manage the video surveillance system.

END OF SECTION

SECTION 28 46 00
FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Comply with provisions of Section 28 05 00 Common Work Results for Electronic Safety & Security.

B. Provide labor, materials, equipment and items of service required for completion of a functionally operative fire alarm system as described in subsequent parts of this section.

C. Include in the bid the cost to furnish and install additional devices required by the Authority Having Jurisdiction during the final inspection. Provide this cost as a separate line item with the unit cost for each device. Turn over to Owner devices not installed at the end of the project with a credit for the installation. Include the following device quantities in the cost:

1. Manual pull stations: 5%, but not less than 4
2. Smoke detectors: 10%, but not less than 10
3. Heat detectors: 5%, but not less than 4
4. Duct smoke detectors with remote switches: 5%, but not less than 4
5. A/V devices or visual devices and speakers: 10%, but not less than 20
6. Monitor modules: 5%, but not less than 4
7. Control modules: 5%, but not less than 4

1.2 RELATED SECTIONS

A. Division 21: Fire Protection System Drawings

B. Division 23: Mechanical System Drawings

1.3 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code

B. NFPA 72 - National Fire Alarm and Signaling Code

C. 10 CFR 1191 - Americans with Disabilities Act

D. NFPA 101 - Life Safety Code

E. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems

1.4 SUBMITTALS

A. Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections. Required items are listed separately for clarity, but system shall be submitted in a single, comprehensive package for review.

1. Specification Compliance Letter

2. Product data sheets for system components highlighted to indicate the specific products, features or functions required to meet the specification.

3. Complete conduit and wiring layout, point-to-point wiring diagram and riser diagram. Include location of all devices and FACU.

4. Complete conduit and wiring layout showing the addition and point-to-point wiring diagram showing the point of connection to existing circuits being utilized. Include location of all devices and FACU.

5. System power and battery charts with performance graphs and voltage drop calculations to assure the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards and providing for a minimum of 10% spare capacity in each.

6. Provide voltage drop calculations for signaling circuits.

7. Select audible device tap settings to provide coverage per NFPA 72 guidelines, and Manufacturer's recommendation.

8. Select strobe candela rating to provide coverage per NFPA 72 guidelines, ADA accessibility guidelines, and Manufacturer's recommendation.

9. Proposed testing plan, indicating edition of NFPA 72, Chapter 14 to which testing is to be performed.

10. Proposed Owner Training Syllabus, list of training materials and estimated time durations for each syllabus line item.

11. Proposal for service and maintenance contract, including all labor costs, itemized parts list cost and travel costs.

12. Provide above design information signed and sealed by a Registered Engineer, in the state where project is located, for submission to the local authority having jurisdiction.

1.5 QUALITY ASSURANCE

A. Designer Qualifications: NICET Level III or IV certified fire alarm technician or registered fire protection engineer, employed by the fire alarm control unit manufacturer, experienced in designing fire alarm systems in the jurisdictional area of the project's AHJ.

B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the type and complexity specified, and of providing maintenance services as a regular part of their business.

1. Installer shall be an authorized installer of the system manufacturer.

2. Installer personnel: Minimum 3 years experience installing fire alarm systems.

3. Supervisor: NICET level III or IV certified fire alarm technician.

4. Contract Maintenance office located within 50 miles of project site.

5. Licensed as a fire alarm installer in the state in which the project is located.

1.6 WARRANTY

A. Refer to Division 1 for additional warranty requirements.

B. Provide manufacturer's warranty for all control panels, annunciators, devices to be free from defects for a period of 1 year after date of Substantial Completion.

C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

1.7 SYSTEM DESCRIPTION

A. System is to be an extension to the new system to be installed under separate project. All components to match components of that system from the same manufacture.

B. Provide a complete, non-coded, addressable, intelligent, microprocessor-based, reporting fire alarm system as indicated on the drawings and as specified herein, including but not limited to the following:

1. Fire Alarm Control Unit (FACU) networked panels.

a. Initiation devices

b. Notification appliances

c. Emergency voice/alarm communications equipment

d. Monitoring and control devices

e. Annunciators

C. Provide control panel with a resident, non-volatile, programmable operating system with the following:

a. Program with logic and supervision for closed loop initiating device circuits, individual alarm appliance circuits and operating power, both A.C. and standby power.

b. Capability of storing and downloading a second set of operating software resident in the control panel as backup in case the primary operating software is corrupted while the system is operating.

c. Capability of on-site programming to accommodate system expansion and facilitate changes in operation.

d. Instructions stored in memory that will not be erased upon loss of primary and secondary power.

D. Provide Fire Alarm Control Unit (FACU) with the following functions:

a. Alarms and trouble conditions that display immediately on the alphanumeric, liquid crystal display indicating the floor level, smoke compartment and device.

b. A system alarm, red LED that flashes until alarm is acknowledged, after which it remains illuminated steadily until system is reset, unless another alarm is received. The alarm LED will flash again and a new description will appear on the liquid crystal display upon receipt of another alarm.

c. A pulsing tone that sounds upon arrival of each alarm, until acknowledged.

d. The ability to scroll through the alarms and troubles existing in the system on the LCD display.

e. An "alarm list" key that displays, in sequence, all possible alarm, trouble and supervisory service control functions.

f. A priority sequence for signals with fire alarm events having the highest priority. Subsequent alarm events will be queued in order received and will not affect existing alarm conditions. Second, third and fourth level priorities will be given to supervisory and trouble events respectively. Signals of higher priority take precedence over signals of lower priority even though the lower priority condition occurred first. Regardless of priority or order received, all events will be annunciated.

g. A means to recall alarms and trouble conditions in chronological order for the purpose of creating an event history. Provide a separate alarm and trouble log with the capacity to store a minimum 300 alarms and 300 trouble events.

h. A system printer that records all alarm, supervisory, and trouble events including type of signal, the device identification, date and time of occurrence.

i. An alarm silence button that, upon acknowledgement of an alarm, silences the audible alarm signals while the visual alarm signals remains operating until the alarm is cleared. Upon receipt of a new alarm event, the system initiates the audible alarm signal again.

E. A system reset button that returns the system to its normal state after the system verifies all circuits or devices are restored to avoid the potential for re-alarming the system. Display message "Alarm Present, System Reset Aborted." if system device is not restored.

F. Provide FACU and system with smoke detector sensor self-checking, compensating and trouble indicating capabilities as follows:

a. Individually monitor smoke detector sensors for calibration, sensitivity, and alarm condition, and to individually adjust for sensitivity.

b. Determine the condition of each sensor by comparing the sensor value to the stored values.

c. Maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.

d. Photoelectric smoke sensors with seven selectable sensitivity levels ranging from 0.2% to 3.7% programmed and monitored from the FACU.

e. Printable sensor reports that meet NFPA 72 calibrated test method requirements that can be utilized for annual recording and logging of the calibration maintenance schedule.

f. Continuous automatic self-test on each sensor that checks sensor electronics and ensures the accuracy of the values being transmitted. Upon test failure of any sensor, indicate a "Self Test Abnormal" trouble condition.

g. Automatic indication when an individual sensor needs cleaning with three progressive levels of reporting as the sensor's average value reaches predetermined values. The progressive levels that will be reached if sensors are left unattended and corresponding system reactions are:

1) First level: indicates an "Almost Dirty" state without creating a trouble on the system.

2) Second level: indicates a "Dirty Sensor" condition that requires attention but that does not affect the sensitivity level required to alarm the sensor, creating a trouble on the system.

3) Third level: indicate an "Excessively Dirty Sensor" and a trouble condition shall be indicated on the control unit.

1.8 SYSTEM OPERATION

A. Initiate an alarm condition on the fire alarm system when one or more of the following devices or inputs are activated:

1. Manual pull station

2. Ceiling mounted smoke and heat detectors

3. Duct mounted smoke detectors in the supply and return ducts of air handling units (Supervisory signal only)

4. Sprinkler system water flow switch

5. Kitchen hood extinguishing system

B. Immediately perform the following alarm sequence when an alarm condition is activated on the system:

1. Annunciate on the fire alarm system identifying the room number, space name and specific device(s) in alarm. (The room number used for identification shall be the room number assigned by the Owner and not necessarily the room number indicated on the floor plans. Coordinate the device description with the Owner.)

2. Initiate a general fire alarm activating all audio/visual appliances.

3. Signal Remote Monitoring Station (without time delay.)

4. Initiate Positive Alarm Sequence timing function for occupant notification.

5. Close doors throughout the facility held open by electric door holders..

6. Unlock all egress doors that are electrically locked via a security or other system.

C. Interface fire alarm system with the HVAC system such that when any device except a manual pull station activates an alarm condition, the following occurs in addition to the actions listed above:

1. Shut down supply and return fans serving the affected area.

2. Close smoke dampers in the affected air handling systems.

3. Shutdown systems 2000 cfm and less that serve egress corridors upon alarm in the respective smoke compartment.

D. Initiate a trouble tone and illuminate an LED light on the FACU to indicate a trouble condition under the following conditions:

1. System wiring short circuit, open circuit or short to ground condition

2. Failure of audio amplifier

3. Failure of tone-generating equipment

4. Failure of primary or secondary power supply

5. Missing or failed initiating device

E. Initiate a supervisory tone and illuminate an LED light on the FACU to provide supervision of each distinct device under the following conditions:

1. Activation of a sprinkler valve status switch

2. Activation of a sprinkler post indicator valve

F. Coordinate the connection of the fire alarm panel with the Audio System Installer. Provide one set of "dry" contacts in FACU and circuiting to the Audio System so that the Fire Alarm system is capable of "capturing" audio system speakers for pre-recorded or live message transmission. Provide audio feed from FACU to Audio System. Upon any fire alarm, send a "power up" signal to the audio system sequencer to activate system if it is powered down when not in use.

G. Positive Alarm Sequence:

1. Upon initiation of alarm, allow 15 seconds to acknowledge the alarm condition and up to 180 seconds and to clear the alarm. These time setting are subject to approval of the AHJ - adjust accordingly.

2. Signal off-site monitoring station immediately (without time delay.)

3. Transmit visual signal and pre-recorded voice evacuation message or override with live voice evacuation message to affected zone(s) if first alarm is not cleared at the end of the time delay.

4. Upon activation of fire alarm occupant notification, signal lighting control system to bring all emergency circuits to full ON status.

H. Upon initiation of alarms in zone(s) with power operated doors in rated walls, send these doors a signal to disable automatic operation and release any specific locking and hold open function. Coordinate with door hardware schedule and specifications.

1. Exception - roll up doors to be released upon local smoke detection and fusible link only.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Provide equipment and devices used for the expansion of the existing system installed under separate contract.

2.2 EQUIPMENT

A. Fire Alarm Control Unit: Provide FACU with the following functions, components and characteristics:

1. UL 864 compliance.

2. Microprocessor based Central Processing Unit (CPU) and power supply in a single cabinet.

3. Lockable steel enclosure with a transparent door panel that prevents tampering while giving full view of controls and alarm lights. Provide door that is site configurable for right or left hand hinging. Where multiple cabinets are required to form a complete control unit, provide matching modular unit enclosures.

4. Power supplies: 24VDC output, sufficient to supply 24VDC to all the fire alarm system equipment connected to the system

5. Support for five RS-232-C ports and one service port with each RS-232-C port capable of supporting multiple, remote TFT plasma displays or printers.

6. Include operator controls that are accessible behind the "see through" access door as follows:

    a. 80 character alphanumeric, LCD display.

    b. Red system alarm LED, separate yellow supervisory service and trouble LEDs, and a green power on LED.

    c. Acknowledge Switch that silences the local panel audible alarm when alarm is acknowledged.

    d. Alarm Silence Switch that silences the general audible alarms throughout the building while keeping the visual alarms active until the system status returns to normal.

    e. Alarm Activate (Drill) Switch that manually activates all notification appliance circuits.

    f. System Reset Switch that causes all initiating devices, appliances or software zones, as well as all associated output devices and circuits to return to their normal condition.

    g. Lamp Test Switch that activates all local system LEDs and light all segments of the liquid crystal display.

    h. Local City Loop Disconnect Switch that allows testing of the system without sending alarms to the central alarm station.

    i. An alpha numeric keypad with easy touch rubber keys for field programming.

7. Provide FACU with capacity sufficient to accommodate the system defined by the contract drawings and these specifications. Include necessary provisions in the power supplies, batteries and system capacities for 25% spare capacity of monitor/control points and annunciation points without requiring the addition of expansion cards, power supplies, batteries, etc.

8. Emergency Voice/Alarm system: Provide emergency voice/alarm system integral to the FACU with the following:

    a. Alarm/evacuation signal generation with multiple built in tones.

    b. Standard or customized digital message storage and message generation.

    c. Multiple digitally recorded human voice messages.

    d. Automatic or manual operations of pre-recorded messages as well as a microphone for live messaging from operator.

    e. Fully supervised NAC speaker circuits that can be manually turned on, off or disabled. Each circuit shall include a custom label to identify its location.

    f. Local panel speaker for message broadcast verification.

B. Smoke Detectors

1. Photoelectric smoke detectors: intelligent (analog) and addressable, utilizing the photoelectric light-scattering principle to measure smoke density. Furnish with the following:

    a. LED's that provide dual alarm and power indication. LED's flash green under normal conditions, indicating that the detector is operational and in regular communication with the FACU. LED's produce a steady red light when an alarm condition has been detected.

    b. Ability to operate a remote alarm LED, an auxiliary relay or an audible base.

    c. Where called for on drawings, provide detector with an integral, resettable, thermistor-based, 135 degree Fahrenheit fixed-temperature heat detector.

2. Duct mounted smoke detectors: intelligent (analog) and addressable, utilizing the photoelectric light-scattering principle to measure smoke density. Furnish with the following:

    a. Sampling tubes of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied.

    b. Air duct housing designed for detection of smoke in HVAC ducts in accordance with NFPA 90. Provide with two test ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test activation of the duct smoke detector.

    c. A supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A @ 28VDC or 1/2 A @ 120VAC. This auxiliary relay operates when the detector reaches its alarm threshold. Mount relay within 3 feet of the HVAC control circuit.

d. LED's that provide dual alarm and power indication. LED's flash green under normal conditions, indicating that the detector is operational and in regular communication with the FACU. LED's produce a steady red light when an alarm condition has been detected.

e. A remote test station with an alarm LED and test switch.

f. UV stabilized plastic weatherproof duct housing with a NEMA 4X rating for use where detectors are installed on ducts located outside on the roof or otherwise. Housing shall circulate conditioned air from duct to maintain detector housing at rated temperature range. Install duct housing per manufacturer's instructions, providing additional ventilated, sheet metal canopy where the housing is mounted in direct sunlight.

3. Beam smoke detectors: intelligent (analog) and addressable, utilizing a transmitter and receiver to project an infrared beam that is monitored by the receiver to determine smoke obscuration. Furnish with the following:

a. LED's that provide dual alarm and power indication. LED's flash green under normal conditions, indicating that the detector is operational and in regular communication with the FACU. LED's produce a steady red light when an alarm condition has been detected.

b. Coverage of distances up to 300 feet.

c. Remote LED status indicator panel with remote test switch for each detector.

C. Heat detectors: intelligent (analog) and addressable, rated for 135 degrees Fahrenheit or 200 degrees Fahrenheit with a rate-of-rise element rated at 15 degrees Fahrenheit per minute. Furnish with the following:

1. Automatic reset.

2. Ability to operating a remote alarm LED, an auxiliary relay or an audible base.

3. Utilize 200 degree heat detectors in spaces with high ambient temperatures such as boiler rooms. Provide a remote module located where ambient temperature is lower and within recommended operating range of the addressable module.

D. Manual Pull Stations: Provide with the following:

1. Double action operation.

2. Red LEXAN or metal finished in red with molded, raised-letter operating instructions of contrasting color. Use metal pull stations where subject to damage.

3. Station to mechanically latch upon operation and remain so until manually reset with a key common with the control units.

4. Provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations where called for on drawings. Include a battery powered piercing warning horn to activate when shield is lifted to gain access to the station. Lowering and realigning the shield will silence the horn. Provide horn with 85dB at 10 feet and 9V battery operation.

E. Addressable Circuit Interface Modules: individually addressable, utilized to monitor and/or control system components that are not otherwise equipped for addressable communication.

1. Monitor modules shall supervise and monitor the status of non-addressable devices with normally open dry contacts. Module shall communicate device status (normal, alarm, trouble) to the FACU.

2. Control modules shall supervise and control the operation of auxiliary devices. Module shall provide double pole, double throw relay switching for 2 amp @30 VDC resistive power limited and at 1/2 amp @120 VAC resistive, non-power limited. It shall contain easily replaceable 2 amp fuses, one on each common leg of the relay.

3. Modules to be capable of mounting in a standard electric outlet box with cover plates to allow surface or flush mounting.

4. Modules shall receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required.

5. All circuit interface modules shall be supervised and uniquely identified by the control panel. Modules shall have an on board LED to provide indication that the module is powered and communicating with the FACU.

F. Alarm Notification Appliances

1. Combination Audible/Visual Devices. Provide UL 1480 listed device with the following:

a. Red, impact resistant and flame retardant thermoplastic covers.

b. High quality voice and tone reproduction, 4" speaker with matching transformer having taps for 1/4, 1/2, 1 or 2 watts at 25 or 70.7 VRMS input.

c. Xenon flash tube and associated lens/reflector system with different flash intensities of 15, 15/75, 30, 75 and 110 candela. Furnish with a visible label inside the lens to indicate the listed candela rating.

2. Ceiling Speaker (Voice capable). Provide UL 480 listed device with the following:

a. Eight inch diameter single voice coil loudspeaker with dual (whizzer) cone and 10 oz. ceramic magnet.

b. Fire-retardant and moisture-proof cone with factory mounted multi-tap transformer and DC blocking capacitor for line supervision.

c. Frequency response of 85 HZ - 8 kHz, +5 dB, power rating of 10 watts, 8 ohm impedance, and a sensitivity of 97 dB peak at 1 watt and 10 feet.

d. Standard round, White grille and a companion enclosure of welded CRS construction, finished in textures black epoxy, and to be undercoated to guard against acoustical and mechanical resonance.

e. Mounting brackets capable of transferring the combined weight of the loudspeaker assembly to the ceiling support members via adjustable rails.

3. Visual Only Strobes. Provide UL 1971 listed device with the following:

a. Xenon flash tube and associated lens/reflector system.

b. Provide with different flash intensities of 15, 15/75, 30, 75 and 110 candela.

c. Provide a visible label inside the lens to indicate the listed candela rating.

d. Mount with Red, impact resistant and flame retardant thermoplastic cover.

e. Wall or ceiling mounted as show on drawings with the "FIRE" lettering oriented for easy reading.

4. Combination Horn/Visual Devices. Provide UL 1480 listed device with the following:

a. Red, impact resistant and flame retardant thermoplastic covers.

b. Electronic horn with loud, penetrating output. Sound output @ 24 VDC equal to 85 dBA @ 10 ft. for reverberant room test and 93 dBA @ 10 ft. for anechoic chamber test.

c. Xenon flash tube and associated lens/reflector system with different flash intensities of 15, 15/75, 30, 75 and 110 candela. Furnish with a visible label inside the lens to indicate the listed candela rating.

5. Combination Audible/Visual Devices, Wet location. Provide UL 1480 listed device with the following:

a. Red impact resistant and flame retardant thermoplastic cover

b. High quality voice and tone reproduction, 4" speaker with matching transformer having taps for 1/4, 1/2, 1 or 2 watts at 25 or 70.7 VRMS input

c. Xenon flash tube and associated lens/reflector system with different flash intensities of 15, 15/75, 30, 75 and 110 candela. Furnish with a visible label inside the lens to indicate the listed candela rating. Where device candela rating does not match values indicated, provide the next higher candela rating.

d. Environmental: -31 degrees F to 151 degrees F, indoor or outdoor use for wet and harsh environments

6. Loudspeakers. Provide UL 1480 listed device with the following for high ambient noise applications:

   a. Red, impact resistant and flame retardant construction, wall or ceiling mounted

   b. 15 watt power rating with 102 dB@15 watts@10 feet output

   c. Transformer selectable for 25/70/100V system operation

   d. Frequency response 400-4000 Hz

G. Magnetic Door Hold Devices. Provide UL 228 listed device with the following:

1. Wall or floor mounting as indicated on drawings, complete with matching doorplate.

2. 24VDC operation (unless otherwise required by the system) developing a minimum of 25 lbs. holding force.

H. Isolator Module

1. Provide modules to automatically isolate wire-to-wire short circuits on an SLC Class A, Class B, or Class X branch, limiting the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch.

2. Provide at least one isolator module for each floor or protected zone of the building.

3. Provide automatic disconnection of the SLC when a wire-to-wire short occurs with automatic reconnection of the isolated section and when the short circuit condition is corrected.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Provide services of a factory authorized service representative to supervise the field assembly and connection of components and the pre-testing, testing and adjustment of the system. Manufacturer's representatives to be available on a 24-hour basis within 150 miles of this project.

B. Provide system complete, in accordance with drawings, specifications and with manufacturer's instructions, including conduit, boxes, wiring and accessories.

C. Device labeling:

1. Coordinate all system programming, including device descriptors, with Owner in advance. Submit final programming for approval prior to implementation.

2. Label all initiating devices and associated remote indicating devices with the specific descriptor of that device. Coordinate with Owner for proper descriptors of each device.

Provide a minimum 3/8-inch high lettering, located on device so it is visible from the ground.

D. Wiring Installation

1. Install wiring in conduit and tag wires at junction points.

2. Obtain from Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. Make no deviation from the written instructions without prior written approval from the Fire Alarm System manufacturer and engineer of record.

3. Color-code fire alarm conductors differently from normal building power wiring. Use one color code for alarm initiating circuit wiring and a different color code for supervisory circuits. Color code notification appliance circuits differently from alarm initiating circuits.

4. For each exterior circuit, in addition to the number of panel wires required, provide a green grounding conductor for operation of transient protection cube. Obtain ground at panel nearest to the point of cube application, but in no case exceed 28 feet of wire length.

5. Provide a dedicated Emergency Power, 120 volt circuit to power the FACU, FEP's, Communication Panels. Provide a red marking on the circuit breakers for these circuits and identify them as "Fire Alarm Circuit", Emergency Communication Circuit or Fire Alarm/ECS circuit as applicable. Ensure circuit breaker lock is installed for each circuit.

E. Smoke detectors:

1. For addressable smoke detectors, permanently write the address in the base so that it is visible with the smoke head removed, where the address is contained in the smoke head.

2. Mount ceiling smoke detectors no less than 3 feet from a supply, return or exhaust air diffusers, and 3 feet from electronic ballasts. Coordinate with division 15 for diffuser locations.

3. Where detectors are installed in concealed locations more than 10 feet above the finished floor, or in arrangements where the detector’s alarm or supervisory indicators are not visible, provide remote LED alarm light and test switch in ceiling close to detector or flush mounted on an adjacent wall.

F. Duct mounted smoke detectors:

1. Provide duct smoke detectors as specified on Division 23 drawings for HVAC supply, return and exhaust fans and ducts. Refer to Division 23 drawings for location and quantities.

2. Install duct smoke detectors in the supply air stream of an air handling unit downstream of filters and at least 6 feet from humidifier, preferably upstream.

3. Install duct smoke detectors within 5 feet of smoke dampers where required.

4. Install duct smoke detectors in the return air stream of an air handling unit on upstream side of outside air inlet.

5. Furnish and connect duct detectors under this Division but install them under Division 23.

6. Support sampling tube within the duct and extend at least 3/4 of the distance across the duct.

7. Mount detectors the appropriate distance from ells, turns, etc. as required by the detector manufacturer.

8. Where duct detectors are mounted above ceilings or above 6 feet in mechanical rooms, provide remote LED alarm light and test switch in ceiling close to detector or surface mounted on an adjacent wall of mechanical room.

G. Alarm Devices:

1. Wire flashing lights separately from audible alarms. When alarm signal is silenced, lights shall continue to flash until the condition responsible for the system alarm has been cleared and reset.

2. Provide synchronized visual devices throughout project.

3. Comply with ADA regulations for mounting of strobe units. Depending upon the configuration of the strobe unit, utilize mounting requirements as follows:

   a. Mount strobe unit 80 inches to bottom of the device faceplate, measured from the highest floor level of area served, and

   b. Entire lens shall not be less than 80 inches or greater than 96 inches above the finished floor.

4. Locate visual alarm devices in sleeping rooms no more than 16 feet from the head of the bed, a minimum of 24" below the ceiling with a rating of 110cd.

5. Locate visual alarm devices in corridors per the plans but no more than 15 feet from the end of a corridor or an interruption of the viewing path such as a corridor door or an elevation change. Locate devices in corridors no more than 100 feet apart.

6. Where devices are required in exterior spaces, in shower room areas, or other wet or harsh environments, provide wet location devices.

H. Water Flow and Tamper Switches:

1. Assign a separately addressable, supervised point and annunciate separately each water flow switch and each valve tamper switch.

2. Connect sprinkler water flow switches, provided under Division 21, to the fire alarm system. Refer to Division 21 drawings for location and quantity of flow switches.

3. Install a valve status switch, furnished under Division 21, on each sprinkler system valve and PIV (Post Indicator Valve). Refer to plumbing drawings and sprinkler system shop drawings for exact location and quantity of valve status switches and PIV switches.

I. System is to automatically actuate certain control functions and monitor or supervise points. Electrically supervise wiring to auxiliary fire alarm relays used to activate such functions or monitor/supervise points. Locate relays within 3 feet of the device controlled, such as a motor starter. Functions for which circuits are to be supervised include, but are not limited to, the following:

1. Release of door hold-open devices

2. Shutdown of selected HVAC systems or activation of smoke control systems

3. Audio system "power up" and control

4. Selected Audio system speaker output shunt (i.e. multi-purpose/lecture rooms, retail, etc.)

5. Elevator hoist way pressurization

6. Sprinkler valve status switches

3.2 TEST AND CERTIFICATION

A. Provide a 10 day minimum notice in writing when the system is ready for final acceptance testing. Send notice after pre-testing has been completed to confirm that the system conforms to the drawings and specifications and malfunctioning or damaged devices have been replaced.

B. Test completed fire alarm system in the presence of Owner's representative and the AHJ. After test, certify test was completed, deficiencies were corrected and system performs as specified.

C. Upon completion of smoke detector installations, test each detector's sensitivity and compare the installed sensitivity with that recorded at the factory when the detector was manufactured and shipped. Replace detectors that test out of limits. Prepare a typewritten tabulation of these tests along with name and signature of tester. Include the following information:

1. Smoke detector descriptor

2. Smoke detector location in the project

3. Sensitivity value - field test

4. Sensitivity value - factory test

5. Within limits - "yes" or "no"

D. Test system in accordance with the procedures outlined in NFPA 72.

3.3 TRAINING

A. Comply with the requirements of Division 1

B. Provide the services of a factory authorized service representative to demonstrate the system and train the Owner's maintenance personnel. Provide a minimum of 16 hours of on-site training. Schedule training with the Owner at least 14 days in advance.

C. Training shall follow the submitted training syllabus and shall be based upon O/M manuals, record documents, system programming, and field demonstrations.

1. Hands-on Instruction: On-site using operational system

2. Classroom Instruction: On-site or at another local facility

a. Administrative

b. Basic Operation

c. Detailed Operation

d. Maintenance, troubleshooting, preventive maintenance and periodic testing requirements

D. Provide means of evaluation of trainees suitable to type of training given, report results to owner.

3.4 CLOSEOUT ACTIVITIES

A. Completion Documents

1. Furnish a written record of inspections, tests, and detailed test results in the form of a test log

2. Prepare the "Fire Alarm System Record of Completion" document per NFPA 72

3. Upon final acceptance furnish the following to the Owner's representative:

a. "Record of Completion" document

b. Owner's manual and installation instructions covering all system equipment

c. Record drawings

d. Copy of system software as programmed

e. Listing of system passwords

f. Spare parts list

END OF SECTION

SECTION 31 23 00
SITE EXCAVATION, FILL, BACKFILL, AND GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Excavating, filling, backfilling, and grading for this work includes, but is not necessarily limited to:
   1. Excavating for footings, foundations, roads, utilities, sidewalks, driveways, parking lots, restoration, and miscellaneous areas.
   2. Furnishing and placing all fill and backfill.
   3. Provide compaction of all fill and backfill.
   4. Furnishing and placing of crushed stone mat below manhole/vault slabs, or other structures where required.
   5. Rough and finish grading prior to paving, seeding, etc.

B. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

C. Payment: Common excavation shall include all excavation specified, undercutting, fill, backfill and grading, except rock excavation and unsuitable foundation material, as hereinafter described.

1.2 REFERENCED STANDARDS

A. Standard Specifications: Unless otherwise indicated, Standard Specifications within this section shall refer to the Indiana Department of Transportation, Standard Specifications, Latest Edition, including all issued Supplemental Specifications.

B. ASTM C33–Standard Specification for Concrete Aggregates.

C. ASTM D698–Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft lbf/ft3 (600 kN m/m3)).

D. ASTM D1557–Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft lbf/ft3 (2,700 kN m/m3)).

1.3 SUBMITTALS

A. Submit sources and gradations for materials proposed for use as compacted fill, utility trench backfill, trench bedding and cover material, crushed stone mat, and granular cushion.

B. Submit samples of materials proposed for use in Paragraph 1.03.A to a soils testing laboratory for analysis of its suitability and for recommendations on moisture content during compaction, compaction methods, or other appropriate information.

C. Submit sufficient samples of each different type or classification of soil to obtain representative values.

1.4 JOB CONDITIONS

A. The elevations shown for existing work and ground are reasonably correct, but are not guaranteed to be absolutely accurate. No extras will be allowed because of variations between drawings and actual grades.

B. Soil borings were made and the soils information is included in an appendix to these Specifications. The information contained is not guaranteed to be indicative of conditions to be encountered during construction. It is CONTRACTOR's responsibility to make its own investigations to determine physical conditions at the site, which may affect the work.

PART 2 - PRODUCTS

2.1 COMPACTED FILL

A. All fill and backfill material designated to be compacted fill shall be granular with no stones larger than 4 inches and shall be reasonably well graded throughout the particle size range. A minimum 65% of the material shall pass the 3/4 inch sieve, and the material shall be capable of being compaction tested in accordance with ASTM D1557 D698, as determined by the Project Soils Engineer. Of that portion of the material passing the No. 4 sieve, not more than 25% shall pass the No. 200 sieve, and material shall have less than 5% clay content. When placing fill during wet weather or in wet areas, this requirement shall be modified to not more than 5% passing the No. 200 sieve. Adequately dewatered areas are not defined as wet areas.

B. Native material may be used as compacted fill if it meets the above specification. CONTRACTOR shall determine whether native material meets the above specification. CONTRACTOR shall provide all needed fill material whether from on site or off site at no additional cost to OWNER.

2.2 CRUSHED STONE MAT

A. Crushed stone mat below manholes and floors shall be 3/4 inch clear crushed stone and shall meet all requirements of ASTM C33 size No. 67.

2.3 EMBANKMENT FILL

A. Embankment fill shall contain no stumps, brush, rubbish, or other perishable material. The top 12 inches of the earth embankment shall be earthy material free from large stones.

2.4 CONCRETE FILL

A. Concrete fill shall be Class X concrete as defined in Section 03 30 00 Cast–In–Place Concrete or flowable fill as defined in this section.

2.5 CLAY FILL

A. Clay fill shall contain at least 25% clay minerals (material finer than 0.002 mm).

2.6 FLOWABLE FILL

A. Flowable fill shall be a self compacting, self leveling, material consisting of a mixture of fine aggregate and filler (as needed), water, and cementitious materials (Portland cement, fly ash, granulated blast furnace slag) that is in a flowable state at the time of placement meeting the requirements of the National Ready Mixed Concrete Association Guide Specification for Controlled Low Strength Materials (CLSM). The flowable fill shall be proportioned by the ready mixed concrete supplier on the basis of field experience and/or laboratory trial mixtures to produce a cohesive and nonsegregating mixture which has the following properties:
1. Minimum compressive strength: 50 psi.
2. Maximum compressive strength: 150 psi.

B. CONTRACTOR shall submit the following information well in advance of fill placement to avoid any delay in construction:
1. Gradation of fine aggregate.
2. Design mix.
3. Previous test results with 7 and 28 day compressive strengths.
4. Certified mill test results for cement identifying brand, type, and chemistry of cement to be used.
5. Brand, type, principle ingredient, and amount of each admixture if used.

2.7 TRENCH BEDDING MATERIAL

A. Bedding material shall be hard and durable and shall be made by crushing sound limestone or dolomite ledge rock, or crushed gravel aggregate. Bedding material shall conform to the requirements of ASTM C33 and shall conform to gradations shown in Table 2.03.A. No native soil shall be used for bedding material.

TABLE 2.03.A
PERCENTAGE BY WEIGHT PASSING INDICATED SIEVE

Size	2 1/2 IN	2 IN	1 1/2 IN	1 IN	3/4 IN	1/2 IN	3/8 IN	No. 4	No. 8	No. 16	No. 30	No. 100	No. 200
57			100	95-100		25-60		0-10	0-5				
8						100	85-100	10-30	0-10	0-5			
9						100	75-100	0-25	0-5				
10							100	85-100				10-30	

B. All rigid sanitary sewer pipe and related appurtenances shall be bedded and covered in accordance with the Drawings. Bedding material shall conform to Size No. 8 or No. 9. With pipes greater than 15 inches, Size No. 57 may be used.

C. Concrete and other rigid pipe used in nonsanitary sewer applications may be bedded as shown on the Drawings. Bedding material shall conform to Size No. 8 or No. 9. With pipes greater than 15 inches, Size No. 57 may be used.

D. Ductile and cast iron pipe shall be bedded in accordance with the Drawings. Bedding material shall conform to Size No. 57, No. 8, or No. 9. Where ductile iron pipe is polyethylene encased, bedding material shall conform to Size No. 8 or No. 9.

E. All other sanitary sewer pipe and related appurtenances shall be bedded and covered in accordance with the Drawings. Bedding material shall conform to Size No. 8 or No. 9. With pipes greater than 15 inches, Size No. 57 may be used.

F. PVC water main or force main shall be bedded and covered in accordance with the Drawings. HDPE water main or force main shall be bedded and covered in accordance with the Thermoplastic Pipe Bedding Detail on the Drawings or in accordance with ASTM D2774. Bedding material shall conform to Size No. 8 or No. 9. With pipes greater than 15 inches, Size No. 57 may be used. No native materials may be used.

G. Bedding material for copper water services shall conform to Size No. 9 or No. 10.

2.8 TRENCH COVER MATERIAL

A. Material which is to be placed from the bedding material to 1 foot above the top of the pipe shall be termed cover material. All trenches shall be backfilled by hand to 1 foot above the top of the pipe with cover material. Cover material shall be deposited in the trench for its full width on each side of the pipe, fittings and appurtenances simultaneously in 6 inch layers and shall be compacted using hand tamping bars and/or mechanical tampers. Use special care in placing cover material to avoid injury to or movement of the pipe. Cover material shall consist of durable granular particles ranging in size from fine to a maximum size of 3/4 inches. Unwashed bank run sand and crushed bank run gravel will be considered generally acceptable cover material. Cover material shall generally conform to the following gradation specifications:

TABLE 2.03.B
COVER MATERIAL GRADATION

Sieve Size	Percentage by Weight Passing
1 inch	100
3/4 inches	85 to 100
3/8 inches	50 to 80
No. 4	35 to 65
No. 30	--
No. 40	15 to 30
No. 200	5 to 15

B. Native trench materials may be used for cover material if they substantially conform to the above gradation specifications and a suitable credit is extended to OWNER.

C. All bedding materials may be substituted for cover material when requested by CONTRACTOR except where polyethylene encasement is used. In such case, only those bedding materials specifically noted for polyethylene encasement may be used.

D. Material that is to be placed from the bedding material around and to 1 foot above the top of all pipes shall be termed cover material. Except as otherwise specified, (a) cover material shall consist of durable granular particles ranging in size from fine to coarse in a substantially uniform combination, (b) unwashed bank run sand and crushed bank run gravel will be considered generally acceptable for cover material, (c) no stones larger than 3/4 inch in their greatest dimension shall be allowed in the cover material, and (d) native materials may be used If they conform to the above specifications. Cover material for copper piping shall be Size No. 10. Cover material for PVC pressure or other thermoplastic piping may be Size No. 10.

2.9 TRENCH BACKFILL MATERIAL

A. Backfill shall be that material placed between the top of cover material up to subgrade for placement of restoration materials. Backfill for storm inlets shall be bedding material.

B. When the type of backfill material is not otherwise specified or shown on the Drawings, CONTRACTOR may backfill with the excavated material, provided that such material consists of loam clay, sand, gravel, or other materials which, in the opinion of Project Soils Engineer, are suitable for backfilling.

C. All backfill material shall exceed a temperature of 35□F and be free from frost, cinders, ashes, refuse, vegetable or organic matter, boulders, rocks, or stone, frozen lumps, or other material which in the opinion of Project Soils Engineer is unsuitable. From 1 foot above the top of the pipe to the trench subgrade, well graded material containing stones up to 8 inches in their greatest dimension may be used, unless otherwise specified. Care should be taken in backfilling so as not to damage the installed pipe.

D. In refilling the trench, if there is not sufficient material excavated therefrom suitable for refilling, CONTRACTOR shall, without extra compensation, furnish the deficiency. Where indicated on the Drawings, fill shall be provided over projecting conduits. Such fill shall be free of large boulders, and the top 6 inches shall be of suitable material to fit the adjoining ground.

E. When called for on the Drawings, in the specifications, or requested by ENGINEER, backfill material shall be granular and shall consist of durable particles ranging in size from fine to coarse in a substantially uniform combination. Sufficient fine material shall be present to fill all the voids in the coarse material. No stones over 3 inches or clay lumps shall be present. Unless otherwise allowed by ENGINEER, granular backfill shall generally conform to the following gradation specification:

GRANULAR BACKFILL

Sieve Size	Percentage by Weight Passing
3 inches	100
2 inches	95 to 100
No. 4	35 to 60
No. 200	5 to 10

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to all excavating, CONTRACTOR shall become thoroughly familiar with the site and site conditions.

3.2 PROTECTION

A. CONTRACTOR shall provide all necessary sheeting, shoring, or other soil retention systems including all labor, material, equipment, and tools required, or as necessary to maintain the excavation in a condition to provide safe working conditions, to permit the safe and efficient installation of all items of Contract work, and to protect adjacent property. CONTRACTOR shall be held liable for any damage which may result to property from excavation or construction operations. Sheeting, shoring, and other soil retainage systems shall be withdrawn or removed in a manner so as to prevent subsequent settlement of structures, utilities, and other improvements.

B. Design of sheet piling and other soil retaining systems shall be the sole responsibility of CONTRACTOR. Where such systems are shown on the drawings, no parameters such as embedment depth, section profile, presence or lack of whalers, etc., nor system type or suitability shall be inferred. CONTRACTOR is responsible for designing and providing a fully functional system compatible with construction and site requirements.

C. Nothing in this specification shall be deemed to allow the use of protective systems less effective than those required by the Occupational Safety and Health Administration (OSHA) and other applicable code requirements.

3.3 FINISH ELEVATIONS AND LINES

A. CONTRACTOR is responsible for setting and establishing finish elevations and lines.

3.4 COMMON EXCAVATION

A. After the site has been cleared and stripped, the site shall be cut and filled to the indicated subgrade as shown or specified.

B. All excavated material that does not meet the specification for compacted fill or embankment fill or meets the specification but is not required for backfill or fill shall be classified as excess material and shall be removed from the site and disposed of at CONTRACTOR's expense.

C. All material other than suitable bearing soil or bedrock, as determined by the Project Soils Engineer, shall be removed from under concrete to be poured on ground.

D. Excavations scheduled to extend below groundwater shall not be started until the area has been dewatered. See Section 31 23 19–Dewatering.

E. No footings or slabs shall bear on the top 2 feet of existing soil. Where planned subgrade is within 2 feet of existing grade, remove soils to 2 feet below existing grade and backfill with compacted fill up to subgrade elevation.

F. When excavations reach subgrade elevations as shown on the drawings or as specified herein, the Project Soils Engineer will observe the bottom material. Where, in the opinion of the Project Soils Engineer, unsuitable foundation material is found at the level of the subgrade, original material below the excavation necessary for construction according to grades shown or specified, shall be removed and replaced with material and placing methods as specified under compacted fill and backfill.

G. Excavations that are undercut beneath the foundation shall extend beyond the perimeter of the foundation 1 foot plus a distance at least equal to the depth of undercut below footing grade.

H. CONTRACTOR shall backfill and compact all overexcavated areas.

I. All street excavation shall be performed as called for in Section 205 of the Standard Specifications and as herein modified.

J. The following items of Work shall be included in common excavation:
   1. The excavation to subgrade elevations as detailed in the Drawings including road bed areas, terraces, sidewalks, bike paths, driveways, and other miscellaneous surface improvements.
   2. Removal (and stockpiling, if the use of salvaged topsoil is required) of topsoil from all cut areas and fill areas within a 1:1 slope of finished street, sidewalks, bike paths, driveways, and other miscellaneous surface improvements.
   3. The preparation, grading, compaction, and proof rolling of subgrade areas for roadbed, sidewalks, bike paths, driveways, and other miscellaneous surface improvements to the elevations detailed on the Drawings.
   4. Excavation and grading required to realign and/or create ditch lines and drainage ways to route drainage to or from storm facilities as shown on the Drawings, or as necessary to maintain positive drainage.
   5. Removal of temporary backfill placed in new utility trenches above the subgrade.
   6. The removal and disposal of all undesirable and surplus materials.

K. Common excavation may be completed as part of utility construction prior to initiating general street excavation activities.

L. All subgrade areas in streets and parking lots, including utility trench restoration areas, shall be proof rolled with a heavily loaded triaxle dump truck or other similar equipment requested by ENGINEER prior to the placement of any fill materials or base course. ENGINEER must be present during proof rolling to review the Work necessary for the stabilization of any unstable areas identified.

M. Saw cuts shall be made in existing pavement, driveways, curb and gutter, and sidewalks to allow restoration to neat straight lines. Saw cuts damaged during construction shall be recut prior to beginning restoration.

N. CONTRACTOR shall salvage suitable materials from utility and street construction activities to provide fill for street construction. Where sufficient quantities of materials suitable for street construction are not available from areas of the site, CONTRACTOR shall perform borrow excavation to make up the deficit in accordance with Section 208 of the Standard Specifications.

3.5 UTILITY TRENCH EXCAVATIONS

A. Caution In Excavation; CONTRACTOR shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures may be determined and shall be held responsible for the repair of such structures when broken or otherwise damaged because of carelessness on its part.

B. Subsurface Exploration: When determined that it is necessary to explore and excavate to determine the location of existing underground facilities, CONTRACTOR shall make explorations and excavations for such purposes. If CONTRACTOR is asked to perform additional Work in making the explorations and excavations, extra compensation will be allowed as specified In the General Conditions.

C. The trench shall be dug so that the utilities can be laid to the alignment and depth specified. Unless otherwise allowed by ENGINEER, trenches shall not be excavated more than 100 feet in advance of pipe laying. Earth excavation shall include all excavation except rock. Included in earth excavation shall be removal of street paving of all types, existing structures, existing improvements and trees smaller than 4 inches in diameter measured 4 feet above the ground, all as necessary to complete the pipe installation.

D. The trench shall be finished to the depth necessary to provide a uniform and continuous bearing and support for the pipe on the bedding material provided at every point between bell holes. Any part of the bottom of trench excavated below the specified grade shall be corrected with bedding material, thoroughly compacted in place. The bedding shall be shaped and finished with hand tools to fit the bottom quadrant to the pipe.

E. If unstable soil conditions are encountered at subgrade, CONTRACTOR shall replace the unstable soil with special bedding. CONTRACTOR shall be allowed extra compensation for the special bedding, unless the unstable soil conditions are

caused by CONTRACTOR's failure to adequately dewater the trench, in which case CONTRACTOR shall bear the entire cost.

F. All excavated material shall be piled in a manner that will not endanger the Work. Stockpiles not for immediate backfilling shall have silt fences placed around their perimeter for erosion control. The Work shall be conducted in such a manner that pedestrian and motor traffic is not unnecessarily disrupted. Fire hydrants, valve boxes and manholes shall be left unobstructed. Gutters shall be kept clear or other satisfactory provisions made for street drainage, and natural water courses shall not be obstructed.

G. Excavated material designated by ENGINEER as being undesirable for backfilling and all surplus excavated material shall be immediately removed as excavation progresses. All such material shall be disposed of in an environmentally safe manner in accordance with local, state, and federal regulations. No such materials shall be disposed of in wetlands, floodplains, or other environmentally sensitive areas. Disposal sites are also subject to approval of OWNER. All undesirable and surplus material disposed of must be leveled off and graded to rough elevations as determined by OWNER. Appropriate erosion control measures shall be provided and maintained at disposal sites until disposal is complete and the disposal site is permanently stabilized.

H. CONTRACTOR shall remove bituminous pavement and road surface as a part of the trench excavation. The width of pavement removed shall be the minimum possible, and acceptable, for convenient and safe installation of utilities and appurtenances.

I. All bituminous pavement shall be cut on neat, straight lines and shall not be damaged beyond the limits of the trench.

J. Where it is necessary to trench through concrete pavement, a strip shall be sawed and removed in such a manner as not to disturb the remainder of the pavement. Paving and undermining of existing concrete pavement shall be prevented by CONTRACTOR. If CONTRACTOR unnecessarily removes or damages pavement or surfaces beyond limits acceptable to ENGINEER, such pavement and surfaces shall be replaced or repaired at the expense of CONTRACTOR.

K. All trees, shrubs, and improved areas outside the excavation shall be protected from damage.

L. Pipe shall be placed only on dry foundations.

M. Excavation shall include all necessary incidental work such as tunneling, sheet piling, shoring, underpinning, pumping, bailing, transportation, and all fill and backfilling.

N. CONTRACTOR shall excavate whatever materials, are encountered as required to place at the elevations shown, all pipe, manholes, and other work as required to complete the project as shown.

O. The excavation at the crossing of all underground utility services in place shall be as narrow as practicable. All underground services shall be protected from damage and maintained in service at their original location and grade during the process of

the work. Any damage to underground services shall be replaced or repaired at no cost to OWNER or to the owner of the service. The present underground services shown on the Drawings are located in accordance with available data. Encountering these services at a different location or encountering services not shown shall not release CONTRACTOR from the above stated conditions

P. Any water, drainage, gas sewer, or electric lines encountered in the excavation that are not to be disturbed shall be properly underpinned and supported. Any service connections encountered that are to be removed shall be cut off at limits of the excavation and capped in accordance within the requirements of or permits governing such removals. Any permits required for this work will be obtained by OWNER upon request of CONTRACTOR.

Q. CONTRACTOR shall be responsible for determining and providing the minimum width necessary to provide a safe trench in accordance with current OSHA standards and all other applicable standards. The top width of trench excavation shall be kept as narrow as is reasonably possible and acceptable to minimize pavement damage. Pay items related to maximum trench widths shall not limit CONTRACTOR's responsibility to provide safe trench conditions.

R. Width of Trench–Rigid Pipe: The width of trench below the outside top of the pipe shall be as shown in the following table for the sizes listed. A minimum clearance of 8 inches between the outside of the pipe barrel and the trench wall at the pipe spring line shall be maintained to allow for bedding and haunching. If sheeting is used and is going to remain in place, the trench width shall be measured as the clear distance between inside faces of the sheeting. Otherwise, the trench width shall be based on the width between stable trench walls after sheeting is removed.

MAXIMUM WIDTH OF TRENCH BELOW TOP OF PIPE

Nominal Pipe Diameter (Inches)	Trench Width (Inches)
4	30
6	30
8	36
10	36
12	36
15	36
18 and larger	NOTE: DETERMINE WIDTH

S. Where the width of trench below the outside top of the pipe barrel cannot be otherwise maintained within the limits shown above, CONTRACTOR, at its own expense, shall furnish an adequate pipe installation for the actual trench width which will meet design conditions. This may be accomplished by furnishing higher class bedding, a stronger pipe, concrete cradle, cap or envelope or by driving sheeting prior to excavation to subgrade. Removal of sheeting below the top of the pipe, if allowed by ENGINEER, shall be gradual during backfilling.

T. If the maximum trench width is exceeded for any reason other than by request of ENGINEER, the concrete cradle, cap, sheeting, bedding or the stronger pipe shall be

placed by CONTRACTOR at its own expense. Where the maximum trench width is exceeded at the written request of ENGINEER, the concrete cradle, cap, sheeting, bedding or stronger pipe will be paid for on the basis of the price bid.

U. Width of Trench–Thermoplastic and Ductile Iron Pipe: The trench width for flexible pipe shall be minimum three times the pipe outside diameter or the maximum trench width specified for rigid pipe, whichever is greater. A minimum clearance of 8 inches between the outside of the pipe barrel and the trench wall at the pipe spring line shall be maintained to allow for bedding and haunching.

V. Special bedding shall consist of stone material and filter fabric as described herein. Where the bottom of the trench at subgrade is found to be unstable or of unsuitable material, which should be removed, CONTRACTOR shall excavate and remove such unstable or unsuitable material to the trench width and to a depth of 2 feet. The excavated area shall be lined with filter fabric, Mirafi 140 N, US Fabrics US 120NW, Propex Geotex 401, or equal, and backfilled with bedding material in maximum 12 inch layers. At subgrade the filter fabric shall be wrapped over the special bedding with an 18 inch overlap. Bedding material shall then be placed over the special bedding to support the piping. See Dewatering and Excavation to Subgrade sections for additional conditions.

W. If soil conditions require it, concrete cradle or encasement shall be placed around the pipe. Excavation shall be carried below the grade line to a depth requested by ENGINEER and concrete cradle or encasement placed. Before the concrete is placed, the pipe shall be laid to line and grade, blocked and braced, and the joint made. The cradle shall then be placed, taking care not to disturb the pipe. Concrete shall have a minimum 28 day compressive strength of 4,000 psi. Concrete cradle shall not be used for thermoplastic piping. See Trench Width section for additional conditions.

X. Open cut trenches shall be sheeted and braced as required by any governing federal regulations including OSHA, state laws, and municipal ordinances; and as may be necessary to protect life, property, improvements or the Work. Underground or aboveground improvements to be left in place shall be protected and, if damaged, shall be repaired or replaced at the expense of CONTRACTOR.

Y. Sheeting and bracing which is to be left in place must be removed for a distance of 4 feet below the present or proposed final grade of the street, road, or land, whichever is lower. Trench bracing, except that which shall be left in place, may be removed after backfilling has been completed or has been brought up to such an elevation as to permit its safe removal.

Z. Portable Trench Box: Whenever a portable trench box or shield is used, special precautions shall be taken so as not to pull already jointed pipe apart or leave voids around the pipe wall. Whenever possible, the bottom edge of the box shall be kept at a level approximately even with the top of pipe. Cover material shall be placed to at least the top of pipe before moving the box ahead.

AA. All trenches shall be backfilled using specified material so that excessive lengths of trench are not left open. In general, the backfilling operation shall proceed so that no more than 100 feet of trench is open behind the pipe laying operation.

BB. Backfill shall be left below the original surface to allow for placement of restoration materials including pavement, base course, concrete, topsoil, sod, plus any pavement replacement specified in accordance with the Asphaltic Paving section herein. When settlement occurs, CONTRACTOR shall restore the surface improvements at its expense to maintain the finished surface.

3.6 PREPARATION OF SUBGRADE

A. After the site has been cleared, stripped, and excavated to subgrade, thoroughly compact subgrade to the requirements specified for compacted fill below. Scarify and moisture condition the subgrade as recommended by the Project Soils Engineer.

B. Remove all ruts, hummocks, and other uneven surfaces by surface grading prior to placement of fill.

C. All slab on grade and road subgrades shall be proofrolled with a heavy rubber tired construction vehicle (such as a fully loaded tandem axle dump truck) in the presence of the Project Soils Engineer.

D. ENGINEER may request the excavation of unsuitable materials in areas of unstable subgrade. The excavation of such materials, except in areas where CONTRACTOR has completed utility construction or placed street fill, shall be measured by ENGINEER for payment.

E. The excavation and replacement of unstable utility trench backfill and/or street fill placed by CONTRACTOR shall be at CONTRACTOR’s expense.

F. Base course placed on unstable foundation shall be removed and replaced at CONTRACTOR’s cost following excavation of the affected area.

G. Where requested by ENGINEER in the field, excavation below subgrade areas shall be lined with geotextile material as specified in Section 31 32 19 and backfilled with 3 inch crushed stone dense graded base as specified herein.

H. Geotextile shall be placed where requested by ENGINEER to stabilize street subgrade areas. Fabric shall be as specified in Section 31 32 19. Vibratory compaction shall not be used in the compaction of base course in areas where geotextile fabrics are used.

3.7 COMPACTED FILL AND BACKFILL

A. All fill and backfill, except as otherwise specified, shall be compacted fill placed to within 4 inches of the bottom of the topsoil or to the bottom of the structure or other improvement.

B. Unless otherwise noted, structures with a top slab shall not be backfilled until the slab is in place and has reached its specified 28 day strength.

C. In fill areas above existing grade around structures, compacted fill shall be placed within a minimum of 10 feet from the structure.

D. No fill shall be placed under water or over unsuitable subgrade conditions.

E. All fill and backfill, except embankment fill and clay fill, shall be compacted as follows:
   1. Class 1 Compaction: This class of compaction shall apply to all fill areas under buildings, structures, piping, bituminous roadway and parking areas, curb and gutter, and backfill within 10 feet of structure walls. All compacted material shall be placed in uniform layers not exceeding 8 inches in loose thickness prior to compaction. Each layer shall be uniformly compacted to a dry density at least 95% of the maximum dry density as determined by a laboratory compaction test at the optimum moisture content (ASTM Test Designation D1557). Compaction shall be obtained by compaction equipment appropriate for the conditions.
   2. Class 2 Compaction: This class of compaction shall be used in excavated areas beyond 10 feet of structures without any piping or adjacent foundations. Material for backfill shall be granular material as specified above. The material shall be deposited, spread, and leveled in layers generally not exceeding 12 inches in thickness before compaction. Each layer of the fill shall be compacted to at least 90% of the maximum dry density (testing same as Class 1). Compaction shall be obtained by compaction equipment appropriate for the conditions.

F. No frozen material shall be placed nor shall any material be placed on frozen ground.

G. Four inches of clay fill shall be placed and compacted to at least a firm consistency in areas to be seeded or sodded prior to placement of topsoil.

3.8 EMBANKMENT FILL

A. Embankment fill may be placed in fill areas to be seeded or sodded if no piping exists in the fill and the areas are at least 10 feet from any structure.

B. Embankment fill shall be deposited, spread, and leveled in layers generally not exceeding 12 inches in thickness before compaction. Each layer shall be compacted to the degree that no further appreciable consolidation is evidenced under the action of the compaction equipment. The required compaction shall be obtained for each layer before any material for a succeeding layer is placed thereon. Compaction shall be obtained using the hauling and leveling equipment, and in addition, tamping rollers, pneumatic tired rollers, vibratory rollers, or other types of equipment required to produce the desired results.

3.9 CONCRETE FILL

A. In areas where there is inadequate room for compaction equipment and in other areas as shown or specified, Class X concrete flowable fill shall be used as fill material.

3.10 PLACING GRANULAR CUSHION AND VAPOR BARRIER

A. When subgrade is prepared for slab on grade areas, CONTRACTOR shall place the vapor barrier and granular cushion.

B. Specific location of vapor barrier (whether directly under slab or under granular cushion) shall be as shown on the drawings.

3.11 PLACING CRUSHED STONE AND GEOTEXTILE FABRIC

A. The same day that the subgrade is exposed, place geotextile fabric on subgrade, and place 12 inches of crushed stone mat below tank slabs, manholes, vault slabs, and basement floors. Compact in place.

B. Geotechnical fabric shall extend up the side edge of the stone mat and extend across the top of the stone to a minimum of 12 inches past the edge of base slab.

3.12 PIPE BEDDING AND COVER

A. Immediately prior to placing the pipe, the trench bottom shall be shaped by hand to fit the entire bottom quadrant of the pipe. If pipe is of the bell and spigot type; bell holes shall be provided to prevent the bell from supporting the backfill load. Bell holes shall be large enough to permit proper making of the joint, but not larger than necessary to make the joint. All adjustments to line and grade must be done by scraping away or filling in bedding material under the body of the pipe. Any fill used must be bedding material. If necessary to obtain uniform contact of the pipe with the subgrade, a template shall be used to shape the bedding material. All pipe shall be placed on bedding material at least 4 inches thick. See

B. Bedding material shall then be placed and tamped into place up alongside the pipe in maximum 6 inch layers shovel slicing the bedding material under the haunches to provide firm contact with the pipe. CONTRACTOR shall perform all necessary excavation and shall furnish all necessary material to provide this bedding.

C. Trenches shall be kept water free and dry during bedding, laying, and jointing. CONTRACTOR shall provide, operate, and maintain all pumps or other equipment necessary to drain and keep all excavation pits and trenches and the entire subgrade area free from water under any and all circumstances that may arise.

3.13 TRENCH BACKFILL CONSOLIDATION

A. All trenches shall be consolidated as specified in this section for the entire depth and width of the trench.

B. Consolidation shall be achieved by use of smooth surface vibratory compactors or backhoe operated hydraulic compactors for granular materials and rotating sheepsfoot type mechanisms for loam/clay soils. The lift height shall not exceed 8 inches for walk behind, hand operated, vibratory compactors and sheepsfoot. Lift height shall not exceed 24 inches for self propelled vibratory drum or backhoe

operated hydraulic compactors. Smaller lift heights shall be provided as necessary to achieve the degree of compaction specified.

C. Unless specified otherwise, backfill material beneath paved areas or future paved areas and within 5 feet of paved areas or future paved areas shall be consolidated as follows: Within 3 feet of the surface 95% of maximum dry density, below 3 feet from the surface to 1 foot above the pipe 90% of maximum dry density, as determined by the modified Proctor Test (ASTM D1557).

D. Unless otherwise specified, backfill material placed in all other areas shall be compacted to the point where no additional consolidation can be observed from the compaction and backfill equipment being used.

E. Backfill material not meeting the compaction specification shall be recompacted by CONTRACTOR at no cost to OWNER. Cost for additional testing on recompacted material shall be at CONTRACTOR’s expense.

3.14 GRADING

A. CONTRACTOR shall perform all rough and finish grading required to attain the elevations shown on the drawings.

B. Grading Tolerances:
   1. Rough Grade: Buildings, parking areas, and sidewalks–±0.1 feet.
   2. Finish Grade: Granular cushion or crushed stone mat under concrete slabs ±0.03 feet.
   3. Lawn areas away from buildings, parking areas, and sidewalks–±0.25 feet.

3.15 MAINTENANCE OF SURFACE

A. CONTRACTOR shall maintain all backfilling, resurfacing, repaving, and other surface improvements constructed under this Contract. CONTRACTOR shall, upon proper notice from OWNER, make all repairs in surfaces of trenches and excavations. All expenses incurred by OWNER and/or CONTRACTOR in making repairs and all expenses in maintaining trench and excavation surfaces shall be at the expense of CONTRACTOR regardless of the material used in backfilling trench excavations. OWNER reserves the right to make all emergency repairs necessary to make safe all streets and walks at the expense of CONTRACTOR regardless of the material used in backfilling trench excavations. A maintenance guarantee fund, if specified, will be withheld from the final amount due CONTRACTOR for a period of 6 months, after acceptance of the Work, to provide such maintenance.

B. CONTRACTOR shall be responsible for controlling dust dispersion during utility and street construction. Remedial actions required as a result of inadequate dust control shall be CONTRACTOR's responsibility. To control dust, CONTRACTOR shall apply calcium chloride or ammonium lignin sulfonate in 12 to 14% solution or other dust control palliative acceptable to OWNER. Prior to application of dust palliative, the street shall be graded smooth.

3.16 COMPACTION TESTING

A. Compaction tests shall be done by the Project Soils Engineer. Location and frequency of the tests shall be as recommended by the Project Soils Engineer and paid for by OWNER.

3.17 EXCAVATED SOLID WASTE FILL MATERIALS TO BE LANDFILLED

A. If any solid waste fill materials are encountered, they shall be excavated and removed to a licensed sanitary landfill. Solid waste fill material is defined as any construction or demolition debris, household refuse, glass, metal, plastic, or similar material not native to the site, but having been placed on site during past filling operations and mixed with soil. Allowance as specified shall apply.

3.18 POTENTIALLY HAZARDOUS WASTE

A. If CONTRACTOR encounters during excavation or trenching activities any potentially hazardous waste as defined in this section, and the materials are within the limits of the site excavation or trenching work, the materials shall be handled as specified in this section. Potentially hazardous waste is defined as any drums, containerized waste, or organic liquid waste or surrounding impacted material. Such materials have not been found during investigations performed to date but could potentially be encountered.

B. Should potentially hazardous waste be encountered, excavation activities in that portion of the site shall be placed on standby pending removal of the material, receipt of test results, and determination by the IDEM and OWNER on whether work may proceed. It is anticipated that this standby time will be approximately 48 hours per occurrence, exclusive of weekends and holidays.

C. Potentially hazardous waste defined above shall be carefully excavated, stockpiled, and tested to determine if they exhibit the characteristics of a hazardous waste as defined by the Indiana Administrative Code Title 329 (329 IAC 3.1 6). Such materials shall be handled according to applicable IDEM, USEPA, and OSHA regulations and shall be stockpiled in a "Temporary Excavated Material Storage Area" as specified in Division 01. Stockpiling shall meet the requirements of IDEM.

END OF SECTION

SECTION 31 23 19
DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:
   1. Removal of groundwater to allow below grade construction.
   2. Site grading to prevent surface water from entering the excavation.

B. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

C. Payment:
   1. The expense for making all extra excavations necessary to prevent water from interfering with the proper construction of the work and for forming all dams or diversions, digging of sumps or pump wells, bailing, and installation and pumping of wells shall be borne by CONTRACTOR.
   2. The cost for removal of groundwater and surface water shall be included in the prices bid for the work. No separate payment will be made for dewatering whether accomplished by use of sumps and pumps, well point systems, deep wells, or any other method.
   3. Any permits necessary for the dewatering operations shall be obtained and paid for by CONTRACTOR.

1.2 REFERENCES

A. See Division 01, Regulatory Requirements for permit requirements and water, erosion, and sediment control.

1.3 SYSTEM REQUIREMENTS

A. CONTRACTOR shall, at its own expense, keep the excavation clear of water while structures, mains, and appurtenances are being built, utilities are being installed, and fill and backfill are being compacted. Under no conditions shall the work be laid in or under water. No water shall flow over the work until the joints are complete or the concrete has set.

B. Wherever necessary, CONTRACTOR shall excavate in advance of the completed work, lead the water into sumps or pump wells, and provide erosion control measures to prevent water or sediment damage.

C. CONTRACTOR’s dewatering system shall perform so that the soils within the trench will not be destabilized by hydrostatic uplift pressures from adjacent groundwater. If conditions warrant, CONTRACTOR shall furnish and install well point systems or deep wells.

D. Dewatering shall be sufficient to lower the piezometric level to at least 2 feet below the bottom of the excavation. Additional lowering shall be provided as necessary to create a stable subgrade.

E. In areas where rock is encountered, the water level shall be kept at or below top of rock, but at least 6 inches below bottom of concrete. Additional rock shall be removed as needed to provide clearances.

F. The control of groundwater shall be such that softening or heaving of the bottom of excavations or formation of "quick" conditions or "boils" shall be prevented.

G. Dewatering systems shall be designed and operated so as to prevent the migration or removal of soils.

1.4 QUALITY ASSURANCE

A. All dewatering shall be done in accordance with applicable federal, state, and local code requirements.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 DEWATERING

A. Dewatering shall be started, and the water level shall be lowered as specified herein prior to beginning excavation and shall be continued until structure, main, or appurtenance has been completed and fill has been placed and compacted to final grade.

B. CONTRACTOR shall provide all necessary materials and equipment to keep the excavation free from water during construction. CONTRACTOR shall at all times have on hand sufficient pumping equipment and machinery in good working condition for all ordinary emergencies, including power outages, and shall have available at all times competent workers for the operation of the pumping equipment. The dewatering systems shall not be shut down between shifts, on holidays or weekends, or during the work stoppages.

C. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted fill or backfill, and prevent floatation or movement of all structures and pipelines.

3.2 PROTECTION

A. CONTRACTOR shall take all necessary precautions during the dewatering operation to protect adjacent structures against subsidence, flooding, or other damage. The dewatering system shall be installed and operated so that the groundwater level outside the excavation is not reduced to the extent that would damage or endanger adjacent structures or property. Any such facilities and structures damaged shall be repaired or replaced to the satisfaction of their owner.

B. Prior to dewatering, CONTRACTOR shall take into account the effect of its proposed dewatering operation on existing private water supply systems and shall make arrangements with property owners for protecting their supplies or providing alternative means of supply.

C. In the event that CONTRACTOR's dewatering operation adversely affects private water supply systems, CONTRACTOR shall provide property owners with alternative potable and nonpotable supplies until dewatering operations are ceased and groundwater levels return to normal. If the water in private water supply wells is contaminated, through no fault of CONTRACTOR, after restoration of original groundwater levels, OWNER will provide measures to restore water potability. CONTRACTOR is responsible for restoration of the water supply, not its potability after restoration.

D. In areas where continuous operation of dewatering pumps is required, CONTRACTOR shall avoid noise disturbance to nearby residences to the greatest extent possible by using electric-driven pumps, or intake and exhaust silencers or housing to minimize noise from engine-driven generators or engine-driven pumps.

END OF SECTION

SECTION 31 25 00
SLOPE PROTECTION AND EROSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Erosion control devices.

B. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

1.2 PAYMENT

A. All costs associated with slope protection and erosion control shall be included in CONTRACTOR's bid. This work shall include, but is not limited to, erecting fence, excavation, placing posts, backfilling, attaching woven wire and geotextile fabric; placing ditch checks; installing sediment traps; removing the fence at completion of project; cleaning and repairing; removing or spreading accumulated sediment to form a surface suitable for seeding; replacing silt fence and damages caused by overloading of sediment material or ponding of water adjacent to silt fence; and furnishing labor, tools, equipment, and incidentals necessary to complete the work in accordance with the Contract.

1.3 REFERENCES

A. Indiana Department of Environmental Management requirements as outlined in 327 IAC 15.

B. Other local requirements.

1.4 REGULATORY REQUIREMENTS

A. Land disturbance greater than 1 acre and CONTRACTOR obtains NOI.
   1. Unless otherwise specified in the SPECIAL PROVISIONS, CONTRACTOR shall, for land disturbance activities exceeding 1 acre, develop and implement a Storm Water Erosion and Pollution Control Plan in accordance with conditions of federal and state permits, local ordinances, Best Management Practices, and as required by the Notice of Intent (NOI).
   2. The following certification shall be included in the Storm Water Erosion and Pollution Control Plan, which CONTRACTOR and all subcontractors shall sign:
      "I certify under penalty of law that I understand the terms and conditions of the General Pollutant Discharge Elimination System (NPDES) Permit that authorizes the storm water discharges associated with industrial activities from the construction site and as may be detailed in the Contract Documents. I agree to indemnify and hold OWNER harmless from any claims, demands, suits, causes of action, settlements, fines, or judgments and the costs of

litigation, including, but not limited to, reasonable attorneys fees and costs of investigation and arising from a condition, obligation or requirement assumed or to be performed by CONTRACTOR for storm water pollution and erosion control."

3. Where land disturbances exceed 1 acre, CONTRACTOR shall execute a Notice of Intent (NOI), including the Public Notice and permit fee, and send to OWNER and the Indiana Department of Environmental Management. CONTRACTOR shall also be responsible for all permit fees.
4. Such controls as identified in the Storm Water Erosion and Pollution Control Plan shall be installed prior to disturbing any soil on the site. CONTRACTOR shall construct, maintain, and remove the erosion and pollution controls in accordance with the plan.
5. CONTRACTOR shall provide a "qualified" inspector to inspect erosion control and pollution controls. Inspector shall have prior experience with erosion and pollution controls and have knowledge of installation and maintenance of erosion and pollution controls as described by the Best Management Practices. Inspector shall be identified in the erosion and pollution control plan. In accordance with the General Pollution Elimination Systems General Permit conditions, the project site erosion control inspection shall be every 7 days and after each 1/2 inch rainfall, or greater. CONTRACTOR shall maintain hard copies of the inspection report with Storm Water Erosion and Pollution Control Plan for the duration of the project.
6. CONTRACTOR shall respond within 24 hours to all corrective measures noted on the inspection report to address pollution issues. CONTRACTOR shall submit to OWNER a written notice stating the times, dates and actions taken to rectify the defective pollution and erosion controls.
7. CONTRACTOR shall pay any fines or other fees resulting from failure of CONTRACTOR to comply with the permit requirements or failure to provide a permit.
8. CONTRACTOR shall submit a "Notice of Termination" (NOT) to IDEM at end of the project.

1.5 QUALITY CONTROL

A. Construct and maintain erosion sediment control measures in accordance with IDEM and the reviewing agency requirements.

B. Check facilities weekly and after any rainfall event, and make needed repairs within 24 hours.

PART 2 - PRODUCTS

2.1 EROSION MATS

A. Uniform web of interlocking wood excelsior fibers, with a net backing on one side. The wood from which the blanket is produced shall have been properly cured to achieve adequately curled and barbed fibers. The blanket shall be of uniform thickness with the wood fibers evenly distributed over the entire area of the

blanket. The blanket shall be furnished in rolled strips. The width of the strips shall be 48 inches, ±1 inch. Weight of blanket measured under average atmospheric conditions shall be 78 pounds per 80 square yards, ±10%. Net backing shall have mesh size not exceeding 1 1/2 by 3 inches and may be woven from twisted paper, cotton cord, a biodegradable plastic, or other alternate method. The blanket shall be nontoxic to vegetation.

2.2 SILT FENCE

A. Use geotextile fabric consisting of either woven or nonwoven polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride with the following requirements. Fabric shall have the minimum strength values in the weakest principal direction. Nonwoven fabric may be needle punched, heat bonded, resin bonded, or combination thereof.

VALUE MINIMUM REQUIREMENTS(1)

Test	Method	Silty Soils(4)	Sandy Soils(5)
Grab Tensile-Strength/ Strip-Breaking Force	ASTM D-5034, D5035(2)	100	100
Mullen Burst Strength (psi)	ASTM D-3786	200	200
Equivalent Opening Size	CW-02215-77	50-140	20-50
U.S. Standard Sieve	Corps of Engineers		
Water Flow Rate (gal/min/ft.^{2} at 50 MM Constant Head	ASTM D-4491(3)	10	10
Ultraviolet Radiation Stability (percent)	ASTM D-4355	90	90

(1) All numerical values represent minimum average roll values (i.e., the average of test results on any roll in a lot should meet or exceed the minimum values in the table).
(2) ASTM D-5034 Grab Test and ASTM D-5035 Breakout Force and Elongation Strip Method, Method 16, using a 4-inch by 8-inch sample, 3-inch gauge length clamped in 1-inch by 2-inch long grip, tested at a strain rate of 12 inches/min.
(3) Water Flow Rate in gal/min/ft shall be determined by multiplying Permittivity in sec. as determined by ASTM D-4491 by a conversion factor of 74.
(4) Silty Soil: More than 15% by weight passing No. 200 sieve.
(5) Sandy Soil: Less than 15% by weight passing No. 200 sieve.

B. Furnish geotextile fabric in a wrapping which will protect the fabric from ultraviolet radiation and from abrasion because of shipping and handling. Keep geotextile dry until installed.

2.3 GEOTEXTILE FABRIC

A. See Section 31 32 19–Geotextiles for fabric under riprap.

2.4 STRAW BALE BARRIERS

A. Provide per INDOT Standard Specifications.

PART 3 - EXECUTION

3.1 GENERAL

A. Install devices before construction activities begin.

B. Proceed carefully with construction adjacent to stream channels to avoid washing, sloughing, or deposition of materials into the stream. If possible, the work area should be diked off and the volume and velocity of water that crosses disturbed areas be reduced by means of planned engineering works (diversion, detention basins, berms).

C. Unless noted on drawings, do not remove trees and surface vegetation.

D. Expose the smallest practical area of soil at any given time through construction scheduling. Make the duration of such exposure before application of temporary erosion control measures or final revegetation as short as practicable.

3.2 EROSION MAT INSTALLATION

A. Place erosion mat immediately after seeding or sodding operations have been completed. Before mat placement, remove all material or clods over 1 1/2 inches in diameter and all organic material or other foreign material which interfere with the mat bearing completely on the soil or sod.

B. Any small stones or clods which prevent contact of the mats with the soil shall be pressed in the soil with a small lawn type roller or by other effective means. The mat shall have its lateral edge so impressed in the soil as to permit runoff water to flow over it.

C. The matting strips shall be rolled on or laid in direction of flow. Spread mat evenly, smoothly, in a natural position without stretching and with all parts bearing on soil, and place blanket with netting on top. Overlap adjacent strips at least 4 inches. Overlap strip ends at least 10 inches. Make overlaps with the upgrade section on top.

D. Bury upgrade end of each strip of fabric or blanket at least 6 inches in a vertical slot cut in the soil and press soil firmly against the embedded fabric or blanket.

E. Anchor mats in place with vertically driven staples, driven until their tops are flush with the soil. Space staples at 3 foot centers along mat edges and stagger space at 3 foot centers through the center. Place staples at 10 inch centers at end or junction slots.

F. Reseed areas damaged or destroyed during erosion mat placing operations as specified for original seeding.

G. Dispose of surplus excavated materials and all stones, clods, or other foreign material removed in the preparation of the seeded soil or sodded surface before placing mat.

H. Following mat placement, uniformly apply water to the area to moisten seedbed to 2 inch depth and in a manner to avoid erosion.

I. Maintain erosion mat and make satisfactory repairs of damage from erosion, traffic, fires or other causes until work acceptance.

3.3 GEOTEXTILE FABRIC

A. Before placing fabric, grade area smooth and remove stones, organic matter, or other foreign material which would interfere with fabric being completely in contact with soil.

B. Place fabric loosely and lay parallel to direction of water movement. Pinning or stapling is acceptable to hold geotextile in place. Overlap or sew together separate pieces of fabric. Overlap joints a minimum 24 inches in the flow direction. After placement, do not expose fabric more than 48 hours before covering.

C. Cover damaged areas with a patch of fabric using a 3 foot overlap in all directions.

3.4 SILT FENCE INSTALLATION

A. Erect silt fence before starting construction operations which might cause sedimentation or siltation at site of proposed silt fence.

B. Construct silt fence in an arc or horseshoe shape with ends pointing up slope. Construct silt fence to the dimensions and details shown on drawings. Remove silt fences after slopes and ditches have been stabilized and turf developed to the extent that future erosion is unlikely. Dispose of materials remaining after removal.

C. Inspect all silt fences immediately after each rainfall and at least daily. Correct deficiencies immediately. Where construction activity changes the earth contour and drainage runoff, make a daily review so that silt fences are properly located for effectiveness. Where deficiencies exist, install additional silt fences.

D. Remove and dispose of sediment deposits. Sediment deposits remaining in place after the silt fence is no longer required shall be dressed to conform with the existing grade and the area topsoiled, fertilized, and seeded as required.

3.5 STRAW BALE BARRIERS

A. Provide as shown on the drawings and as necessary on ditch lines and other drainageways to minimize construction sediment laden runoff to downstream ditches and channels and into streams.

B. Inspect all barriers immediately after each rainfall and at least daily. Correct deficiencies immediately. Where construction activity changes the earth contour and drainage runoff, make a daily review so that barriers are properly located for effectiveness. Where deficiencies exist, install additional straw bales.

C. Remove and dispose of sediment deposits. Sediment deposits remaining in place after the barrier is no longer required shall be dressed to conform with the existing grade and the area topsoiled, fertilized, and seeded as required.

END OF SECTION

SECTION 31 32 19
GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included: Geotextiles for areas below structures, at perforated drain pipe trenches, pressure relief valves, below base course, and below riprap.

B. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Geotextile for areas below structures for use at perforated drain pipe trenches and pressure relief valves and as specified elsewhere, shall be Mirafi 140N, or equal.

B. Geotextile below riprap shall be Mirafi 180N, or equal.

C. Geotextile below base course shall be Mirafi 500X, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Geotextile shall be installed in accordance with manufacturer’s recommendations.

B. Geotextile shall be lapped a minimum of 24 inches.

C. If extensive areas of unstable subgrade are encountered on street areas, ENGINEER may request the furnishing and installation of construction fabric to obtain the necessary subgrade support for the roadway structure. Vibratory compaction shall not be used in the compaction of base course in areas where construction fabrics are used.

D. CONTRACTOR shall protect the construction fabric from exposure to the sun until installation. Construction fabric shall be covered with stone or soil immediately upon placement.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSE

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:
   1. Aggregate base course for roads and parking areas.
   2. Gravel roads.

B. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

C. CONTRACTOR is cautioned that existing private and public roads and shoulders may not hold up to typical construction traffic or activities. CONTRACTOR shall repair all roads, shoulders, and gravel areas damaged in accordance with this section. All paved areas shall also be repaired in accordance with Section 32 11 26–Hot Mix Asphalt Paving.

1.2 MEASUREMENT AND PAYMENT

A. Repair or replacement of aggregate base course shall be considered incidental and included in the price bid.

1.3 REFERENCES

A. Standard Specifications: Unless otherwise indicated, Standard Specifications shall refer to the Indiana Department of Transportation, Standard Specifications, Latest Edition, including all issued supplemental specifications.

1.4 DEFINITIONS

A. Street or road shall include streets, roads, driveways, and parking lots.

1.5 SUBMITTALS

A. Submit sieve analysis for proposed materials in accordance with Section 01 33 00–Submittals.

1.6 DRAINAGE DURING CONSTRUCTION

A. CONTRACTOR shall comply with the provisions of Section 203 of the Standard Specifications.

PART 2 - PRODUCTS

2.1 AGGREGATES FOR BASE COURSE FOR ROADS AND PARKING AREAS

A. Aggregates for base course shall meet the requirements of Section 301 of the Standard Specifications.

B. Base course shall be uniformly graded and shall conform to the requirements of Section 300. Base course shall be Type 53. All remaining base course shall be Type 53.

2.2 AGGREGATES FOR GRAVEL ROADS

A. Aggregates for base course shall consist of crushed stone and shall the requirements of Section 303 of the Standard Specifications. The material furnished shall be uniformly graded and shall conform to ASTM C33.

B. Base course shall be uniformly graded and shall conform to the requirements of Section 300. The top 3 inches of base course shall be Type 73. All remaining base course shall be Type 53.

C. Material for top layer of shoulders shall meet the requirements of Type 73.

PART 3 - EXECUTION

3.1 PREPARATION

A. The subgrade shall be graded and rolled to provide uniform density and shall comply with the profile and cross sections contained in the drawings. All street subgrade in cut areas and all areas to receive fill shall be proof rolled in the presence of OWNER or ENGINEER with a heavily loaded triaxle dump truck, or similar equipment prior to the placement of any fill materials or base course. The subgrade shall be prepared in accordance with Section 207 of the Standard Specifications.

3.2 CONSTRUCTION

A. Base course grade shall be set to allow placement of thickness of asphaltic or concrete pavement shown or specified.

B. Depth of base course shall be provided according to the standard cross sections or details provided on the drawings.

C. Depth of base course shall be the existing depth or 9 inches, whichever is greater.

D. Base course shall be placed directly on subgrade areas or on top of salvaged asphalt millings unless otherwise indicated on the Drawings.

E. Each layer of base course shall be wetted and rolled to provide maximum compaction in accordance with Section 300 of the Standard Specifications.

F. The finished base course shall be fine graded in preparation for paving.

G. After final grading, CONTRACTOR shall maintain the base course until asphaltic or concrete paving work has been completed.

H. All gravel surfaces damaged during construction shall be replaced. The depth of aggregate shall match existing or 8 inches, whichever is greater.

END OF SECTION

SECTION 32 11 26
HOT MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes Hot Mix Asphalt (HMA) paving, tack coat, and casting adjustments.

B. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

C. CONTRACTOR is cautioned that existing private and public roads and shoulders may not hold up to typical construction traffic or activities. CONTRACTOR shall replace all roads, shoulders, and paved areas damaged during the project in accordance with this section. Gravel shoulders, gravel roads, and parking areas shall be repaired in accordance with Section 32 11 23–Aggregate Base Course.

1.2 MEASUREMENT AND PAYMENT

A. Payment: Payment for HMA paving shall be considered incidental to the project and included in the Lump Sum Bid.

1.3 REFERENCES

A. Standard Specifications: Unless otherwise indicated, Standard Specifications shall refer to the State of Indiana Department of Transportation, Standard Specifications, Latest Edition including all issued supplemental specifications.

1.4 DEFINITIONS

A. Street or road shall include streets, roads, driveways, and parking lots.

1.5 SUBMITTALS

A. Prior to the commencement of paving, mix designs and aggregate sieve analysis shall be submitted to ENGINEER for approval in accordance with Section 01 33 00–Submittals.

PART 2 - PRODUCTS

2.1 HMA PAVEMENT

A. Asphaltic pavement shall be Section 402 HMA Type B. Asphaltic binder for lower course and upper course shall be PG 64 22 per Section 902.

B. Aggregate shall conform to the requirements of Section 904. Aggregate for the intermediate course shall be nominal size of 3/4 inch. Aggregate for the surface course shall be nominal size of 1/2 inch.

C. Replacement of paved surfaces shall be 4 inches in thickness or existing thickness, whichever is greater. Lower layer shall be 2 1/4 inches minimum. Upper layer shall be 1 3/4 inches minimum.

D. Materials for tack coat shall conform to the requirements of Section 406.

PART 3 - EXECUTION

3.1 ALLOWABLE REMOVAL OF PAVEMENT

A. CONTRACTOR shall remove asphalt pavement and road surface as a part of the general excavation. The width of pavement removed shall be the minimum possible and acceptable for convenient and safe installation of structures, utilities, and appurtenances.

B. All asphalt pavement shall be cut on neat, straight lines and shall not be damaged beyond the limits of the excavation. Should the cut edge be damaged, a new cut shall be made in neat, straight lines parallel to the original cut encompassing all damaged areas. Pavement removal shall be extended to a seam or joint if seam or joint is within 3 feet of damaged pavement.

3.2 CASTING ADJUSTMENTS

A. All new and existing manhole castings and valve boxes within the paving limits of the street, which require adjustment, shall be adjusted to match the finished asphaltic surface. Adjustments shall not be made greater than 48 hours prior to the anticipated time of paving. Adjustments shall be performed as called for in Section 33 30 10–Buried Piping and Appurtenances. CONTRACTOR shall furnish Class 1 barricades with flashers on all adjusted castings until paving has been completed. Tops of castings and valve boxes shall be oiled or protected by other methods to prevent sealing of lids and filling of lift holes during paving. Upon completion of paving operations, CONTRACTOR shall check all castings and valve boxes to see that the lids are clean and operational. Manhole casting adjustment shall be included in the cost of other items of work, and no further compensation will be made. Valve box adjustment shall be considered an incidental item of work.

3.3 TACK COAT

A. All work shall be in accordance with the Standard Specifications.

B. If asphaltic upper course is applied to an existing street or is not applied the same day as intermediate course, the existing street or intermediate course shall be tack coated prior to surface paving. Prior to placement of tack coat, the streets shall be thoroughly cleaned and broomed. Tack coat shall be applied at a rate of 0.10 gallons per square yard immediately prior to placement of asphaltic surface course.

C. In situations where traffic must be maintained, tack coat shall not be placed on the traveled half of the street until traffic can be switched to the new pavement.

3.4 JOINTS

A. Joints between old and new pavements or between successive day's work shall be constructed and treated to provide a thorough and continuous bond between the old and new mixtures. Transverse construction joints shall be constructed by cutting the material back for its full depth so as to expose the full depth of the course. Where a header is used, the cutting may be omitted provided the joint conforms to the specified thickness. These joints shall be treated with tack coat material applied with a hose and spray nozzle attachment to fully coat the joint surface.

B. The longitudinal joint shall be made by overlapping the screed on the previously laid material for a width of not more than 2 inches and depositing a sufficient amount of asphaltic mixture so that the finished joint will be smooth and tight. Longitudinal joints in the surface course shall at no time be placed immediately over similar joints in the intermediate course beneath. A minimum distance of 12 inches shall be permitted between the location of the joints in the intermediate course and the location of similar joints in the surface course above.

C. All costs for furnishing and applying tack coat to butt joints as specified above shall be considered incidental.

3.5 FINISHING ROADWAY

A. The finished base course shall be fine graded in preparation for HMA paving. Base course ramps at all existing pavement shall be removed to provide a full depth butt joint. Base course around manhole castings and valve boxes shall be hand trimmed and compacted with a vibratory plate compactor.

B. This item shall include all of the following preparatory and finishing items and any other incidental items of work required for construction. Asphaltic ramps around manholes on existing intermediate course to receive surface course shall be removed. Asphaltic ramps shall be installed on all manholes and at all butt joints in areas to receive intermediate course only.

C. Finishing roadway shall be considered incidental to HMA paving.

3.6 TESTING HOT MIX ASPHALT

A. ENGINEER may require samples of HMA pavement for testing. CONTRACTOR shall cut samples from the finished pavement where marked by ENGINEER and patch the sample area. Samples for sieve analysis and asphalt content will be taken by ENGINEER prior to placement.

3.7 HOT MIX ASPHALT PAVING

A. HMA paving work shall include the construction of plant mixed hot mix asphalt pavement in the areas shown on the drawings. All work shall be performed in accordance with Section 402 of the Standard Specifications.

B. Prior to commencement of paving operations, CONTRACTOR shall examine the finished road bed. CONTRACTOR shall notify ENGINEER of any areas of suspected instability.

C. The pavement structure for streets, roads, driveways, and parking lot construction shall be determined from the standard cross sections provided on the drawings.

END OF SECTION

SECTION 32 16 13
CONCRETE CURB AND GUTTER, SIDEWALKS, AND DRIVEWAY APRONS

PART 1 - GENERAL

1.1 SUMMARY

A. Work includes concrete curb and gutter, sidewalks, and driveway aprons as shown on the drawings.

B. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

1.2 MEASUREMENT AND PAYMENT

A. All costs of the Work shall be included in the Lump Sum Bid.

1.3 REFERENCES

A. Standard Specifications: Unless otherwise indicated, Standard Specifications shall refer to the Indiana Department of Transportation, Standard Specifications, Latest Edition including all issued supplemental specifications.

B. AASHTO M148 Standard Specifications for Liquid Membrane–Forming Compounds for Curing Concrete.

1.4 QUALITY ASSURANCE

A. Unless otherwise specified, all curb and gutter, sidewalks, and driveway apron construction shall meet the requirements of the Standard Specifications.

PART 2 - PRODUCTS

2.1 CONCRETE

A. All concrete shall be Class A as specified in Section 03 30 00–Cast in Place Concrete.

OR

B. All concrete shall conform to Section 604 of the Standard Specifications for sidewalk and driveways and Section 605 for curb and gutter.

2.2 CURING COMPOUND

A. Liquid curing compounds shall conform to the requirements of the Standard Specifications for Liquid Membrane Forming Compounds for Curing Concrete, AASHTO Designation M148, Type 2, White Pigmented.

PART 3 - EXECUTION

3.1 BASE PREPARATION–CURB AND GUTTER

A. The base course beneath the curb and gutter shall be trimmed or filled as necessary to provide a full depth of curb and gutter as detailed in the Drawings. Prior to placement of concrete, the base shall be thoroughly compacted and moistened.

3.2 BASE PREPARATION–SIDEWALKS AND DRIVEWAYS

A. The subgrade shall be thoroughly compacted and finished to a trim, firm surface. All soft or unsuitable material shall be removed and replaced with suitable material.

B. A minimum 4 inch thick layer base course shall be placed under all sidewalks. This material shall be thoroughly moistened and compacted before the concrete is placed.

3.3 FORMS

A. Forms shall be of metal and of sufficient strength to resist distortion or displacement. Metal forms shall be used to construct a curb and gutter cross section as shown on the Drawings. Forms shall be full depth of the required work. Facing boards, if used, shall be built so as to obtain the cross section called for on the drawings. Forms shall be securely staked and held firmly to line and grade. Forms shall be cleaned thoroughly and oiled before reuse.

B. All curved curb and gutter shall form smooth curves and shall not be a series of chords. Radius forms shall be used for all curved curb and gutter where the radius of curvature is 100 linear feet or less.

3.4 PLACING AND FINISHING CONCRETE

A. Unless otherwise specified, concrete shall be placed in accordance with

B. Section 03 30 00 Cast-in-Place Concrete.

C. Concrete shall be thoroughly tamped to remove all voids. The exposed surfaces of the curb and gutter shall be thoroughly troweled and finished with a brush at right angles to the line of the curb and gutter. The back edge of the curb, the edge of the gutter adjacent to the pavements, and edges adjacent to expansion joints shall be

rounded with a 1/4 inch radius edger. Honeycombed areas along the back of the curb shall be pointed with mortar.

D. Before final finishing of curb and gutter, a 10 foot straight edge shall be used to check the surface. Any areas showing a variation of more than 1/4 inch from the straight edge shall be corrected. Final finishing shall be delayed a sufficient time so that excess water and grout will not be brought to the surface.

E. Concrete for sidewalk shall be placed to a minimum thickness of 5 inches, except at driveways and alleys, which shall have a minimum thickness equal to that of the driveway. Driveways shall have a minimum thickness of 8 inches. The concrete shall be thoroughly spaded and tamped to remove all voids. The surface of the driveway or sidewalk shall be thoroughly troweled and finished with a brush at right angles to the driveways or sidewalk line.

3.5 MACHINE FORMED CURB AND GUTTER

A. CONTRACTOR may elect to use a machine for placing, forming, and consolidating concrete curb and gutter. If a machine is used, the resulting curb and gutter shall be of such a quality as to equal or exceed that produced by the method described above.

3.6 DRIVEWAY OPENINGS

A. Driveway openings will be staked by CONTRACTOR in the field. The details for curb and gutter through a driveway is shown on the Drawings.

3.7 REJECT SECTIONS

A. At locations shown on the drawings, the curb and gutter shall be warped so as to reject the flow of water. The transition from a standard section to a reject section shall not be abrupt but shall be a minimum of 10 feet in length. The reject section shall conform to the detail shown on the Drawings.

3.8 JOINTING–CURB AND GUTTER

A. A 3/4 inch expansion joint filler shall be placed through the curb and gutter at the radius points of all intersection curbs. This expansion joint filler shall extend through the entire thickness of concrete and shall be perpendicular to the surface and at right angles to the line of the curb and gutter.

B. At intervals of not more than 10 feet, a contraction joint shall be tooled to a depth of 1/5 of the total concrete thickness with a 1/4 inch radius jointer. The contraction joint shall be at right angles to the line of the curb and gutter.

C. If machine formed curb and gutter is provided by CONTRACTOR, CONTRACTOR shall create a plane of weakness at all joints that is sufficient to cause contraction cracking at the joints.

D. CONTRACTOR may saw contraction joints. The depth of cut shall be a minimum of one fifth of the total concrete thickness. Sawing shall be done as soon as practicable after the concrete has set sufficiently to preclude raveling during the sawing and before any shrinkage cracking takes place in the concrete. If this method results in random cracking, CONTRACTOR will be required to tool the contraction joints as specified above.

E. The use of steel separator plates will not be allowed.

F. Jointing shall be included in the price bid for curb and gutter.

3.9 JOINTING–SIDEWALKS AND DRIVEWAYS

A. Concrete sidewalk shall be cut into rectangular blocks approximately 5 feet long. The cut must extend at least 1/5 of the total thickness of concrete. The edges of the sidewalk along forms and joints shall be rounded with an edging tool of 1/4 inch radius. All joints shall be at right angles to the centerline of the sidewalk.

B. Concrete driveways shall be jointed in approximately square sections. The depth of the joint and the finishing of the edges shall be the same as for concrete sidewalk.

3.10 EXPANSION JOINTS

A. A 1 inch thick expansion joint filler shall be placed between curb ramps and back of curb.

B. A 1/2 inch thick expansion joint shall be placed at all sidewalk corners, between sidewalks and buildings, and between back of curb and sidewalk.

3.11 SLOPE

A. Sidewalk cross slope shall be 1/4 inch per foot unless otherwise noted in the drawings or requested by ENGINEER.

3.12 CURB RAMP

A. Curb ramps shall be constructed in accordance with the Drawings.

3.13 INLET CASTING ADJUSTMENT

A. Inlet casting shall be adjusted to grade as required for the installation of the new curb and gutter. Inlet casting backs shall be adjusted for a depressed flow line at all inlets in the low points (0.72 feet); all other inlet shall be adjusted for a normal flow line (0.50 feet).

3.14 UTILITY MARKINGS

A. The ends of utility service lines (sewer, water, and electrical conduits) shall be marked during installation. The curb top shall be marked immediately adjacent to these utility markers. Curb markers shall be 2 inches in height and shall consist of a "W" for water, "S" for sewer, and "E" for electric and blank conduits. Markings shall be embossed a minimum of 1/4 inch deep and be 3/8 inches thick. Utility markings shall be considered incidental work to curb and gutter.

3.15 CURING

A. As soon after finishing operations as the free water has disappeared, the concrete surface shall be sealed by spraying on it a uniform coating of curing material in such a manner as to provide a continuous water impermeable film on the entire concrete surface.

B. The material shall be applied to form a uniform coverage at the rate of not less than one half gallon per 100 square feet of surface area.

C. Within 30 minutes after the forms have been removed, the edges of the concrete shall be coated with the curing compound applied at the same rate as on the finished surface.

3.16 PROTECTION OF CONCRETE

A. CONTRACTOR shall erect and maintain suitable barricades to protect the new concrete. Where it is necessary to provide for pedestrian traffic, CONTRACTOR shall, at his own cost, construct adequate crossings. Crossing construction shall be such that no load is transmitted to the new concrete.

B. Any part of the work damaged or vandalized prior to final acceptance shall be repaired or replaced at the expense of CONTRACTOR in a manner satisfactory to ENGINEER.

C. Pedestrian traffic shall not be permitted over new concrete prior to 72 hours after application of curing material. Vehicular traffic shall not be permitted over newly placed concrete within seven days after completion when temperatures are 70°F or higher, 10 days when temperatures are not lower than 60°F and up to a maximum of 21 days when the temperatures are generally lower than 60°F.

END OF SECTION

SECTION 32 17 23.13
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This section describes furnishing and installing pavement markings conforming to the Indiana Department of Transportation Standard Specifications, Latest Edition, Section 808 and as shown on the Drawings.

1.2 MEASUREMENT AND PAYMENT

A. The cost of this shall be included in the lump sum bid.

1.3 REFERENCES

A. Indiana Transportation Standard Specifications, Latest Edition, Section 808.

1.4 SUBMITTALS

A. Submittals shall be in accordance with provisions of Section 01 33 00–Submittals.

PART 2 - PRODUCTS

2.1 PAVEMENT MARKINGS

A. Provide beads, cones, multi-component, preformed plastic, snow-plowable, raised pavement markers, thermoplastic, temporary pavement marking tape, temporary raised pavement markers in accordance with Indiana Department of Transportation Approved Materials List.

PART 3 - EXECUTION

3.1 PAVEMENT MARKINGS

A. Place markings in accordance with Section 808 of the Standard Specifications.

B. Centerline marking shall be double 4-inch solid yellow line placed at the marked centerline.

C. Traffic lane marking shall be single 4-inch broken white line placed 12 feet from median curb flange or as shown, or requested by ENGINEER. Turning-lane

markings and crosswalk markings shall be 8 inches and 6 inches solid white, respectively. Stop bars shall be 18 inches solid white.

D. Markings shall be placed at locations noted within 1-inch tolerance.

END OF SECTION

SECTION 32 18 13 - SYNTHETIC GRASS SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. ALTERNATE NO. 3: Artificial grass and synthetic turf systems.

2. ALTERNATE NO 2: Turf Protection system

B. Related Sections:

1. Division 1 Section "Alternates"

2. Division 9 Section “Portable Wood Athletic Flooring”

1.3 REFERENCE STANDARDS

A. FM P7825 – Approval Guide; Factory Mutual Research Corporation; current edition.

B. ASTM Standard Test Methods:

D1577 – Standard Test Method for Linear Density of Textile Fiber
D5848 – Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Covering
D418 – Standard Test Method for Testing Pile Yarn Floor Covering Construction
D1338 – Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings
D1682 – Standard Method of Test for Breaking Load and Elongation of Textile Fabrics
D5034 – Standard Test Method of Breaking Strength and Elongation of Textile Fabrics (Grab Test)
F1015 – Standard Test method for Relative Abrasiveness of Synthetic Turf Playing Surfaces
D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity
D2859 – Standard Test Method of Ignition Characteristics of Finished Textile Floor Covering Materials
E-648 – Flooring Critical Radiant Panel Test (Flame Spread)
F355 – Standard Test Method for Shock-Absorbing Properties of Playing Surfaces
F1936 – Standard Test Method for Shock-Absorbing Properties of North American Football Field Playing Systems as Measured in the Field
D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
F2898 – Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method

C. Comply with all NFHS & IHSA Rules & Interpretations.

1.4 SUBMITTALS

A. Substitutions: Other products are acceptable if in compliance with all requirements of these specifications. Submit alternate products to Architect for approval prior to bidding in accordance Section 01 25 00, Product Substitution Procedures.
   1. Provide substantiation that proposed system does not violate any other manufacturer's patents, patents allowed or patents pending.
   2. Provide a sample copy of insured, non-prorated warranty and insurance policy information.

B. Comply with Section 01 33 00, Submittals Procedures. Submit for approval prior to fabrication.

C. Shop Drawings:
   1. Indicate field layout; field marking plan and details for the specified sports; i.e., NFHS Football and Soccer; roll/seaming layout; methods of attachment, field openings and perimeter conditions.
   2. Show installation methods and construction indicating field verified conditions, clearances, measurements, terminations, drainage.
   3. Provide joint submission with related trades when requested by Architect.

D. Product Data:
   1. Submit manufacturer's catalog cuts, material safety data sheets (MSDS), brochures, specifications; preparation and installation instructions and recommendations; storage, handling requirements and recommendations.
   2. Submit fiber manufacturer's name, type of fiber and composition of fiber.
   3. Submit data in sufficient detail to indicate compliance with the contract documents.
   4. Submit manufacturer's instructions for installation.
   5. Submit manufacturer's instructions for maintenance for the proper care and preventative maintenance of the synthetic turf system, including painting and markings.

E. Samples: Submit samples, 6 x 6 inches, illustrating details of finished product in amounts as required by General Requirements, or as requested by Architect. Provide samples for two turf colors.

F. Product Certification:
   1. Submit manufacturer’s certification that products and materials comply with requirements of the specifications.
   2. Submit test results indicating compliance with Reference Standards.

G. Project Record Documents: Record actual locations of seams, drains and other pertinent information in accordance with Division 1 Specifications Series, General Requirements.

H. List of existing installations: Submit list including respective Owner’s representative and telephone number.

I. Warranties: Submit warranty and ensure that forms have been completed in Owner's name and registered with approved manufacturer.

J. Testing data to the Owner to substantiate that the finished field meets the required shock attenuation, as per ASTM F1936.

K. Testing Certification: Submit certified copies of independent (third-party) laboratory

reports on ASTM testing:

1. Pile Height, Face Weight & Total Fabric Weight, ASTM D5848.
2. Primary & Secondary Backing Weights, ASTM D5848.
3. Tuft Bind, ASTM D1335.
4. Grab Tear Strength, ASTM D1682 or D5034.

1.5 QUALITY ASSURANCE

A. Comply with Section 01 40 00, Quality Requirements.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section. The turf contractor and/or the turf manufacturer:

1. Shall be experienced in the manufacture and installation of specified type of synthetic monofilament grass turf for a minimum of five years with the same manufacturer, product and company they are proposing for this field. This includes use of a split film fiber, and the installation method.
2. Shall have 500 fields in play for at least two years with the same fiber. Fields shall be 18,000 ft^2 or more
3. Turf manufacturer shall have installed a minimum of 500 fields that are at least 8 years old, which is equal to the respective warranty period.
4. Shall have a minimum of 10 installations in the State of Illinois.
5. Shall have minimum 15 NCAA Division 1 game and/or practice fields installed with the same fiber.
6. Shall provide third party certification confirming minimum requirement of 9 lbs tuft bind.

C. Installer: Company shall specialize in performing the work of this section. The Contractor shall provide competent workmen skilled in this specific type of synthetic grass installation.

1. The designated Supervisory Personnel on the project shall be certified, in writing by the turf manufacturer, as competent in the installation of specified monofilament material, including sewing seams and proper installation of the infill mixture.
2. Installer shall be certified by the manufacturer and licensed.
3. The installer supervisor shall have a minimum of 5 years experience as either a construction manager or a supervisor of synthetic turf installations

D. Pre-Installation Conference: Conduct conference at project site at time to be determined by Architect. Review methods and procedures related to installation including, but not limited to, the following:

1. Inspect and discuss existing conditions and preparatory work performed under other contracts.
2. In addition to the Contractor and the installer, arrange for the attendance of installers affected by the Work, The Owner’s representative, Construction Manager and the Architect.

E. The Contractor shall verify special conditions required for the installation of the system.

F. Prior to the beginning of installation, the installer of the synthetic turf shall inspect the sub-base and accept in writing the sub-base surface planarity and compaction. The installer shall have the dimensions of the field and locations for markings measured by a registered surveyor to verify conformity to the specifications and applicable standards. A record of the finished field as-built measurements shall be made.

G. The Turf Contractor shall provide the necessary testing data to the owner that the finished field meets the required shock attenuation, as per ASTM F1936.

H. The Contractor shall notify the Architect of any discrepancies.

1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with Section 01 60 00, Product Requirements.

B. Deliver and store components with labels intact and legible.

C. Store materials/components in a safe place, under cover, and elevated above grade.

D. Protect from damage during delivery, storage, handling and installation. Protect from damage by other trades.

E. Inspect all delivered materials and products to ensure they are undamaged and in good condition.

1.7 WARRANTY

A. See Division 1 - Closeout Procedures, For Additional Warranty Requirements.

B. The Contractor shall provide a warranty to the Owner that covers defects in materials and workmanship of the turf for a period of eight (8) years from the date of substantial completion. The turf manufacturer must verify that their representative has inspected the installation and that the work conforms to the manufacturer's requirements.

C. The manufacturer's warranty shall include general wear and damage caused from UV degradation. The warranty shall specifically exclude vandalism, and acts of God beyond the control of the Owner or the manufacturer.

D. The Turf Manufacturer’s Warranty must be supported by an insurance policy for the full eight (8) year period.

E. The Turf Contractor shall provide a Warranty to the owner that covers defects in the installation workmanship, and further warrant that the installation was done in accordance with both the Manufacturer’s recommendations and any written directives of the Manufacturer’s on-site representative.

F. All turf warranties shall be non-prorated, limited to repair or replacement of the affected areas, at the option of the Manufacturer, and shall include all necessary

materials, labor, transportation costs, etc. to complete said repairs. All warranties are contingent on the full payment by the Owner of all pertinent invoices.

G. The artificial grass field turf must maintain an ASTM 355 G-max of less than 200 for the life of the Warranty.

H. Third Party – The Contractor shall provide the Owner a Certificate of insurance for the warranty period of the turf stating that a Third Party Insurance Company is providing protection to the Owner of the Turf field from the Turf Manufacture and Turf Installer's inability to make warranty repairs.

1.8 MAINTENANCE SERVICE

A. Contractor shall train the Owner's facility maintenance staff in the use of the turf manufacturer's recommended maintenance equipment.

B. Manufacturer must provide maintenance guidelines to the facility maintenance staff.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Basis of Design: "Vertex" (Fieldturf) or equivalent by one of the following manufacturers:

1. Shaw Sports Turf; Legion
2. AstroTurf; Rhino Blend
3. MondoTurf; True Blend
4. Greenfields; Allsport Ultra

2.2 MATERIALS AND PRODUCTS

A. Artificial grass system materials shall consist of the following:
1. Carpet made of slit film fiber or a blended system of slit film fiber tufted into a perforated backing with coating system.
2. Infill: Graded sand and rubber crumb that partially covers the carpet.
3. Glue, thread, paint, seaming fabric and other materials used to install and mark the artificial grass monofilament.

B. Carpet Rolls shall be 15' wide rolls.
1. Rolls shall be long enough to go from field sideline to sideline.
2. Where the playing field is for football, the perimeter white line shall be tufted into the individual sideline rolls.
3. Alternate colors of turf as 5 yard marks as indicated on the drawings.

C. Backing:
1. Primary backing shall be a double-layered polypropylene fabric treated with UV inhibitors.
2. Secondary backing shall consist of an application of porous, heat-activated urethane to permanently lock the fiber tufts in place.

3. Perforated (with punched holes), backed carpet are unacceptable.

D. Fiber shall be 9000 denier, low friction, and UV-resistant fiber measuring not less than 2 inches high.
   1. Systems with less than 2 inch fibers are unacceptable.

E. Infill materials shall be approved by the manufacturer.
   1. The infill shall consist of a resilient-layered, granular system, comprising selected and graded dust-free silica sand and SBR rubber crumb
   2. The sand component of the infill must represent a minimum of 40% or more of the total infill, by weight.

F. Non-tufted or inlaid lines and markings shall be painted with paint approved by the synthetic turf manufacturer.

G. Thread for sewing seams of turf shall be as recommended by the synthetic turf manufacturer.

H. Glue and seaming fabric for inlaying lines and markings shall be as recommended by the synthetic turf manufacturer.

2.3 QUALITY CONTROL IN MANUFACTURING

A. The manufacturer shall own and operate its own manufacturing plant in North America. Both tufting of the field fibers into the backing materials and coating of the tuft system must be done in-house by the turf manufacturer. Outsourcing of either is unacceptable.

B. The manufacturer shall have full-time certified in-house inspectors at their manufacturing plant that are experts with industry standards.

C. The manufacturer’s full-time in-house certified inspectors shall perform pre-tufting fiber testing on tensile strength, elongation, tenacity, denier, shrinkage, and twist i.e., turns per inch, upon receipt of fiber spools from fiber manufacturer.

D. Primary backing shall be inspected by the manufacturer’s full-time certified in-house inspectors before tufting begins.

E. The manufacturer’s full-time in-house certified inspectors shall verify “pick count”, yarn density in relation to the backing, to ensure the accurate amount of face yarn per square inch.

F. The manufacturer’s full-time, in-house, certified inspectors shall perform turf inspections at all levels of production including during the tufting process and at the final stages before the turf is loaded onto the truck for delivery.

G. The manufacturer shall have its own, in-house laboratory where samples of turf are retained and analyzed, based on standard industry tests, performed by full-time, in-house, certified inspectors.

H. The manufacturer must have ISO 9001, ISO 14001 and OHSAS 18001 certifications demonstrating its manufacturing efficiency with regards to quality, environment and safety management systems.

2.4 FIELD GROOMER & SWEEPER

A. Supply field groomer as part of the work.
   1. Field Supply a field groomer, which shall include a towing mechanism compatible with a field utility Vehicle to be supplied by the Owner.

   2. The field groomer shall be the FieldTurf RT Groomer (Phone 1-800-724-2969) or approved equal.

2.5 TURF PROTECTION SYSTEM

A. **ALTERNATE NO. 2:** Supply Turf Protection System in an area quantity 5% larger than the Portable Wood Athletic Floor.
   1. Basis of Design: FieldTurf Armour HU or equivalent as approved by the selected Synthetic Turf manufacturer.
   2. Product must be suitable for chairs, equipment, trailers, vehicles, and trucks.

PART 3 - EXECUTION

3.01 GENERAL

A. The installation shall be performed in full compliance with approved Shop Drawings.

B. Only trained technicians, skilled in the installation of athletic caliber synthetic turf systems working under the direct supervision of the approved installer supervisors, shall undertake any cutting, sewing, gluing, shearing, topdressing, or brushing operations.

C. The designated Supervisory personnel on the project must be certified, in writing by the turf Manufacturer, as competent in the installation of this material, including sewing seams and proper installation of the Infill mixture.

D. All designs, markings, layouts, and materials shall conform to all currently applicable National Collegiate Athletic Association rules and other standards that may apply to this type of synthetic grass installation.

3.02 EXAMINATION

A. Verify that all sub-base, drainage and leveling is complete prior to installation.

B. The surface to receive the synthetic turf shall be inspected by the Installer, and prior to the beginning of installation, the Installer must accept in writing the sub-base surface planarity and compaction. The surface must be perfectly clean as installation commences and shall be maintained in that condition throughout the process.

C. The compaction of the aggregate base shall be 95%, according to the Modified proctor procedure (ASTM D1557), and the surface tolerance shall not exceed 0-1/4 inch over 10 feet and 0-1/2" from design grade.

D. Correct conditions detrimental to timely and proper completion of Work.

E. Do not proceed until unsatisfactory conditions are corrected.

F. Beginning of installation means acceptance of existing conditions.

3.03 PREPARATION

A. Prior to the beginning of installation, inspect the sub-base for tolerance to grade.

B. Sub-base acceptance shall be subject to receipt of test results (by others) for compaction and planarity that sub-base is in compliance with manufacturer's specifications and recommendations.

C. Dimensions of the field and locations for markings shall be measured by a registered surveyor to verify conformity to the specifications and applicable standards. A record of the finished field as-built measurements shall be made.

D. Installed sub-base shall be tested for porosity per ASTM F2898 prior to the installation of the turf. A sub base that drains poorly is an unacceptable substrate.

3.04 INSTALLATION

A. Install in accordance with manufacturer's instructions. The Turf Contractor shall strictly adhere to the installation procedures outlined under this section. Any variance from these requirements must be accepted in writing, by the Manufacturer's on-site representative, and submitted to the Architect / Owner, verifying that the changes do not in any way affect the warranty. Infill materials shall be approved by the Manufacturer and installed in accordance with the manufacturer's standard procedures.

B. The carpet rolls are to be installed directly over the properly prepared aggregate base. Extreme care should be taken to avoid disturbing the aggregate base, both in regard to compaction and planarity. It is suggested that a 2-5 ton static roller is on-site and available to repair and properly compact any disturbed areas of the aggregate base.

C. The full width rolls shall be laid out across the field. Turf shall be of sufficient length to permit full cross-field installation from sideline to sideline. No head or cross seams will be allowed in the main playing area between the sidelines. Utilizing standard state of the art sewing procedures each roll shall be attached to the next. When all of the rolls of the playing surface have been installed, the sideline areas shall be installed at right angles to the playing field turf.

D. This is a 99% sewn installation. Gluing of rolls shall not be acceptable. Minimum gluing will only be permitted to repair problem areas, corner completions, and to cut in any logos or inlaid lines as required by the specifications. All seams shall be sewn using double bagger stitches and polyester thread or adhered using seaming

tape and high grade adhesive (per the manufacturer's standard procedures). Seams shall be flat, tight, and permanent with no separation or fraying.

E. Infill materials shall be applied in numerous thin lifts. The turf shall be brushed as the mixture is applied. The infill materials shall be installed to a depth determined by the Manufacturer.

F. The Infill materials shall be installed to fill the voids between the fibers and allow the fibers to remain vertical and non-directional. The Infill installation consists of a base layer of sand followed by a homogenous mixture of the sand and the cryogenically processed rubber. A final application of specifically sized cryogenically processed rubber completes the system.

1. 2 1/2" Turf - The Infill shall be installed to the depth of 1 1/4". Infill density shall consist of no more than 2 pounds of sand and at least 3 pounds of rubber per square foot. The Infill shall be placed so that there is a void of ¾" to the top of the fibers.

G. Prior to the application of any line painting, the turf shall be fibrillated by means of a nylon rotary brush to provide the look, feel, and safety of optimally maintained natural grass, including subtle undulations normally associated with natural grass athletic fields.

H. Non-tufted or inlaid lines and markings shall be painted according to the recommendations of the turf Manufacturer and of the paint manufacturer. Number of applications will be dependent upon installation and field conditions.

I. Synthetic turf shall be attached to the perimeter edge detail in accordance with the Manufacturer's standard procedures.

J. Upon completion of installation, the finished field shall be inspected by the installation crew and an installation supervisor.

3.05 FIELD MARKINGS

A. The field will have the following lines inlaid according to NFHS standards:

1. Soccer
2. Football
3. Men's Lacrosse
4. Women's Lacrosse

B. Standards

1. Standards: All lines and marking shall be to IHSA & NFHS Standards.

3.06 CLEANING

A. Protect installed Turf from subsequent construction operations.

B. Do not permit traffic over unprotected floor surface.

C. Contractor shall provide the labor, supplies, and equipment as necessary for final cleaning of surfaces and installed items.

D. All usable remnants of new material shall become the property of the Owner.

E. The Contractor shall keep the area clean throughout the project and clear of debris.

F. Surfaces, recesses, enclosures, etc., shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

END OF SECTION 32 18 13

SECTION 32 92 00
RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:
1. Placement of topsoil.
2. Fertilizing.
3. Seeding.
4. Mulching.
5. Maintenance.

B. All areas disturbed by street, curb and gutter, and sidewalk construction shall be restored. Backslopes adjacent to the sidewalk shall be seeded to the slope intercept. Borrow sites and disposal sites will not require seeding, but they shall be graded smooth.

C. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

D. Payment: Payment for restoration shall be at the lump sum price bid. Costs for topsoiling, seeding, fertilizer, mulching, and maintenance of restored areas shall be included in the lump sum price bid. One percent of the total Contract price shall be retained following project completion until a uniform 2 inch growth of vegetation is established over all restored areas.

1.2 REFERENCES

A. Standard Specifications: Unless otherwise indicated, Standard Specifications shall refer to the State of Indiana Department of Transportation, Standard Specifications, Latest Edition, including all issued supplemental specifications.

1.3 QUALITY ASSURANCE

A. All work shall be in accordance with Standard Specifications, unless noted otherwise.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, stones greater than 3/4

inches in size, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

B. Topsoil from the site may be used if it meets the above requirements.

2.2 SEED

A. Seed mixture shall be Type 2 conforming to Section 621of the Standard Specifications.

2.3 FERTILIZER

A. Fertilizer shall conform to Section 621 of the Standard Specifications.

PART 3 - EXECUTION

3.1 TOPSOIL

A. Placing topsoil shall be in accordance with Section 621 of the Standard Specifications. Topsoil shall be placed to a uniform depth of 6 inches in place. Topsoil placement shall be incidental to sodding or seed, fertilizer, and mulching.

3.2 SEEDING

A. Seeding placement shall conform to Sections 621 of the Standard Specifications.

B. Seed shall be applied at the rates specified in Section 621 of the Standard Specifications.

3.3 FERTILIZER

A. Fertilizer shall be applied per Section 621 of the Standard Specifications.

3.4 MULCHING

A. All areas receiving seed shall be mulched.

B. Mulching shall be performed in accordance with Section 621 of the Standard Specifications.

3.5 MAINTENANCE

A. Seeding/sodding shall proceed concurrently with construction. Seeding/sodding shall be maintained by CONTRACTOR until grass is well established. Grass is well established when it covers the entire seeded areas to a height of 2 inches.

B. Mow sod at regular intervals to maintain at a maximum height of 2 1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.

C. Immediately remove clippings after mowing.

D. Water to prevent seed/sod and soil from drying out.

E. Roll surface to remove minor depressions or irregularities.

F. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

G. Immediately reseed areas which fail to show adequate catch. Bare spots shall not exceed 5 square feet in area and not exceed 3% of the total seeded areas.

H. Immediately replace sod in areas which show bare spots or deterioration.

I. Protect seeded areas with warning signs during maintenance period.

J. Correct damage resulting from erosion, gullies, rills, or other causes by filling with topsoil, tamping, refertilizing, and reseeding or resodding if damage occurs prior to acceptance of work.

END OF SECTION

SECTION 33 00 10
BURIED PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:
1. All underground piping, valves, and appurtenances of every description.
2. Excavation, dewatering, and backfilling for all work under this section unless otherwise noted.
3. Concrete foundations and anchor bolts for all equipment furnished under this section.
4. Underground piping connections to all equipment, whether furnished under this section or not.

B. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

1.2 REFERENCED SPECIFICATIONS

A. INDOT Specifications in the Standard Specifications shall refer to the State of Indiana Department of Transportation, Standard Specifications, Latest Edition, including all amendments.

B. Conservation Practice Standards in the Standard Specifications shall refer to the Indiana Department of Environmental Management Indiana Stormwater Quality Manual.

1.3 CODES AND STANDARDS

A. Comply with the requirements of:
1. Indiana Administrative Code, Article 25, Fuel Gas Code and applicable standard(s).
2. NFPA 54–National Fuel Gas Code (Current Edition).
3. Polyethylene gas distribution piping shall be installed in accordance with CFR 49, Part 192, Subpart G (mains), Subpart H (service lines), applicable codes and regulations, and ASTM D2774.

B. Before any polyethylene fusion welding is performed, CONTRACTOR shall submit certification that the welders to be used on this project have successfully demonstrated proper welding procedures in accordance with the Code of Federal Regulations, Title 49, Part 192, Section 192.285.

C. ENGINEER and OWNER reserve the right to test the work of any welder employed on the project, at CONTRACTOR's expense. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project.

1.4 SUBMITTALS

A. Shop Drawings: General arrangement drawings of 3 inches or larger exterior (belowground) ductile iron, stainless steel and welded steel piping shall be submitted to ENGINEER for approval. Drawings shall include proposed materials, length, location, and elevation of pipe, fittings, pipe restraint, valves, and appurtenances.

PART 2 - PRODUCTS

2.1 MATERIALS OF CONSTRUCTION

A. All materials used in the manufacture, assembly, and painting of piping and valves in contact with water shall be compatible with potable water supplies and in contact with chemical feed systems shall be compatible with the chemicals being used. All glues, solvents, solders, etc., shall likewise be compatible. For instance, no lead base solders shall be used. All materials in contact with water to be used for potable water supplies shall be National Sanitation Foundation (NSF) approved.

B. Size and Type:
   1. All materials shall conform to the size and type shown on the Drawings or called for in the specifications.
   2. In joining two dissimilar types of pipe, standard fittings shall be used when available. In the event standard fittings are not available, the method of joining shall be standard selected by CONTRACTOR and submitted for review by ENGINEER.

C. Materials provided shall be suitable for the conditions in which they are being installed and used. CONTRACTOR shall review installation requirements of the Contract with material suppliers and incorporate any additional installation requirements necessary to meet the required use within the price bid for the Work.

D. All pipe and materials used in performance of the Work shall be clearly marked as to strength, class, or grade. Pipe and materials not so marked shall be subject to rejection.

E. When requested by ENGINEER, material suppliers shall furnish certificates of compliance indicating that all tests required by various Standards have been conducted and that the text results comply with the Standards.

F. Piping appurtenances shall be made of the materials specified. All appurtenances not designated as to type shall be selected by CONTRACTOR and submitted for review by ENGINEER.

G. All Sanitary sewer related items and water main/appurtenances shall conform to Columbus City Utilities Standard Specifications which can be downloaded from the Columbus City Utilities website.

H. All storm sewer related items shall conform to the City of Columbus, Indiana's Standard Details which can be downloaded from the Columbus, Indiana Engineering website.

2.2 MANHOLES

A. All provisions shown on the Drawings enclosed in these specifications, except those contrary to provisions delineated herein or on the Drawings shall apply to manholes.

B. Unless otherwise specified or shown on the Drawings for special manholes, all manholes shall be reinforced concrete precast manholes. Reinforced concrete manhole base sections, riser sections, cones, and flat slabs shall conform to the requirements of ASTM C478. Solid precast manhole bottoms shall be provided except where shown on the Drawings. Diameters shall be increased from the minimum for the following:
   1. To provide between adjacent pipe a minimum distance equal to one-half the outside diameter of the largest pipe measured circumferentially along the inside face of the manhole.
   2. To accommodate flexible manhole connections used.
   3. To accommodate multiple valves or valve assemblies.

C. Manhole top sections shall be precast reinforced eccentric cones unless precast reinforced flat slabs are specifically required or shown on the Drawings or are necessary because of shallow depth. Flat slabs shall have opening offset unless otherwise required or shown. Flat slabs shall be designed for HS20 loadings.

D. Unless otherwise specified or shown on the Drawings, all underground utility structures shall be precast, reinforced concrete. Reinforced concrete base sections, riser sections, and flat slabs shall conform to the requirements of ASTM C858. Flat slabs shall be designed for HS20 loadings. Solid precast bottoms shall be provided unless otherwise shown on the Drawings.

E. Manhole Chimney Adjusting Rings:
   1. Provide concrete manhole adjusting rings.
   2. Precast concrete adjusting rings for standard manholes shall have an inside diameter of 26 inches, be not less than 2 inches nor more than 6 inches high, and shall have a wall thickness of 6 inches unless otherwise specified. The rings shall contain a minimum of one No. 2 reinforcing rod centered within the ring. The joints between rings and between rings and castings shall be sealed with preformed flexible joint sealant as specified herein.

F. Manhole Chimney Seals:
   1. External manhole chimney seals shall be provided for all new manholes. Chimney seal shall be Cretex, or equal.
   2. Existing manholes exposed during the construction period shall have the adjustment rings replaced and a new chimney seal installed. Existing castings shall be reused.

G. Valve Boxes:
1. A valve box shall be provided for fire hydrant auxiliary valves and for valves in the main. The valve box shall be centered and plumb over the wrench nut of the valve with the box cover flush with the finished ground elevation. Solid 4 inch concrete blocks shall be placed under the base of valve boxes so that the bottom of the base is about 2 inches away from contact with the valve bonnet. A Gate Valve Adaptor by Adaptor Inc., or equal, shall be provided. The valve box shall not transmit shock or stress to the valve.
2. Valve boxes shall be made of cast iron conforming to ASTM A48. The castings shall be free from blowholes, porosity, hard spots, shrinkage defects or cracks, or other injurious defects and shall have a normal smooth casting finish. The castings shall be thoroughly coated with a 1 mil minimum thickness bituminous coating. Valve boxes shall be 5 1/4 inches in diameter. Valve boxes shall have a maximum length of 7 feet when extended without extension sections. Extensions shall be provided for deeper mains.
3. Valve boxes shall consist of a base section, tubular mid and top sections, both with cast threads by which one can be telescoped on the other, extension sections if required, and a circular drop cover unless indicated otherwise.
4. Valve boxes shall be installed in accordance with Drawing 01 975 64A.
5. Valve boxes shall be Tyler/Union 6850 Series, 4 inches through 12 inches, or equal. Extension heights shall be provided as required. Lids shall be marked for appropriate use. CONTRACTOR shall verify that all valve boxes are large enough to accommodate all operating nuts and wrenches. Provide one “Tee” valve key operator for each valve manhole and one for each tank with tank or channel drain.

H. Precast Reinforced Concrete Manholes:
1. Lengths of manhole riser (barrel) shall be furnished in such combinations as to conveniently make up the depth of the manhole. A maximum of two handling holes per length of riser will be permitted.
2. Drop entrances to sanitary sewer manholes shall be installed where indicated on the Drawings. Drop entrances shall be of the same diameter as the sewer main from sizes 8 inches through 18 inches. For larger diameters, the drop shall be 18 inches unless otherwise shown on the Drawings. Drop entrances for storm sewer manholes are not required.
3. The interior bottom of sanitary sewer and storm sewer manholes shall be constructed of concrete benches which shall be precast or poured in place in the field. Benches shall extend to the top of each pipe to a maximum height of 42 inches. Flow lines shall be made smooth with uniform curves to promote flow through the manhole.
4. All joints between manhole pipe sections and top shall be tongue and groove conforming to ASTM C443. Manhole joints shall be sealed with circular O ring or preformed flexible joint sealant that shall be Ram nek, Kent Seal, Mas stik, or equal.
5. Manhole connections for sanitary sewer mains shall be made using flexible, watertight connections, PSX Press Seal, Kor N Seal, or equal, for sewers up through 18 inch diameter. All other sanitary sewer manhole connections shall be made with A Lok, PSX Press Seal, Kor N Seal, or equal. The joint shall provide a flexible, watertight connection between pipe and manhole. Manhole

connections for storm sewer mains and leads may be made with cast in place concrete during completion of manhole interior in lieu of above.

6. Manhole bottoms for sanitary sewer shall be monolithically precast with the bottom section for manholes up through 6 foot diameter. Bottoms for larger diameter manholes shall be precast but need not be monolithically cast with the bottom section. All other manhole bottoms shall be either poured in place or precast concrete.
7. Manhole bottoms for air release manholes, force main cleanout manholes and water system valve manholes shall have an 18 inch diameter sump hole. Sump hole shall have a solid concrete bottom where groundwater is above the bottom of the manhole.
8. Manholes shall be furnished of minimum diameters as shown on the Drawings. Manholes shall be furnished large enough to provide a minimum distance, between adjacent pipe, measured tangentially along the inside face of the manhole, equal to one half the outside diameter of the intersecting sewer pipe. In any event, manholes shall be furnished in the diameter necessary to accommodate intersecting sewer pipe and the pipe to manhole connection as proposed for use.
9. Steps shall be installed in all manholes by the manufacturer as shown on the Drawings and shall be cast iron conforming to ASTM A48 or steel reinforced plastic conforming to ASTM A615, Grade 60 and ASTM D4101 with molded copolymer polypropylene covering conforming to ASTM D4101, Type PP200B33450Z02, or equal. Manhole steps shall be spaced 16 inches on center with an allowable tolerance of (plus or minus) 1 inch. Steps shall be inserted in manhole riser, cone, and flat slab sections prior to the initial set of the concrete in accordance with ASTM C478 and shall have maximum embedment and pullout resistance in accordance with ASTM C497. The top step shall be located 10 inches or less from the top of the manhole cone section or uppermost structure section. Manhole steps shall be Neenah Type R 1981 N, M.A Industries, Inc. PS1 PF, or equal.
10. Precast reinforced concrete manhole risers and tops shall be tested in accordance with ASTM C497. Precast reinforced concrete manhole risers and tops meeting the strength requirements will be considered acceptable and shall be stamped with an appropriate monogram. When requested, copies of test reports shall be submitted to ENGINEER before the manhole sections are installed in the Project. Final acceptance will be made after field inspection upon delivery to the jobsite.
11. Precast reinforced concrete manhole sections shall be subject to rejection for failure to conform to any of the requirements of the Standard Specifications. In addition, individual sections of manhole risers and tops may be rejected because of any of the following reasons:
    a. Fracture or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
    b. Defects that indicate imperfect proportioning, mixing, and molding.
    c. Surface defects indicating honey combed or open texture.
    d. Damaged ends, where such damage would prevent making a satisfactory joint.
    e. Manhole steps out of line, or not properly spaced.
    f. Noticeable infiltration into manhole.
    g. Variation in diameter of the manhole section of more than 1% from the nominal diameter.

h. Any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more regardless of position in the section wall.

I. Each precast reinforced concrete manhole riser and top section shall be clearly marked with the name or trademark of the manufacturer and the date of manufacture. This marking shall be indented into the manhole section or shall be painted thereon with waterproof paint.

J. Storm Sewer Inlets:
1. All inlets shall meet the requirements of ASTM C913.
2. Construction shall conform to the Drawings and the City of Columbus, Indiana's Standard Details.
3. Inlets, in general, shall be rectangular in shape and shall be constructed of precast concrete.

K. Masonry:
1. Concrete block shall meet the requirements of ASTM C139.
2. The face size of stretcher units shall be 7 5/8 inches by 15 5/8 inches. Variations in the face size shall be within the limits permitted by the above standards. Special shapes and sizes shall be furnished and installed as necessary.
3. Sewer brick shall conform to ASTM C32. All sewer brick shall be Grade SS and manhole brick shall be Grade MS. Sewer brick shall be installed as shown on the Drawings furnished by ENGINEER and as required in the construction of sewer appurtenances.

L. Manhole, Inlet Frames and Castings, Hydrodynamic Separator, and Underground Detention System:
1. Sanitary Sewer Manhole Castings:
   a. Frames and covers shall be provided from the openings indicated on the Drawings.
   b. For standard manholes, frames shall be East Jordan Iron Works 1020z, or equal, with Type A HD lid, with two concealed pickholes equipped with self sealing gaskets.
2. Storm Sewer Manhole frames and covers to be Neenah R - 1772, or approved equal. Lid to be Type "B" with concealed pickhole and shall conform to the City of Columbus, Indiana City Standards
3. Castings for curb inlets shall be Neenah R-3246, Type V Grate, or equal.
4. All curb inlets with modified manholes are to be standard INDOT manholes as specified in structure data table, modified to accept a Neenah R-3246, Type V Grate, or Equal.
5. All area inlets located in pavement areas are to be Standard INDOT manholes as specified in the structure data table with a Neenah R-3405, Type D4 rate, or Equal.
6. All area inlets located in grassed areas are to be INDOT E7 unless otherwise specified in structure data table.
7. All Nyloplast Drainage Basins are to be from Advanced Drainage Systems, Inc., or approved equal. Grates are to be Solid option. Drainage Basins are to be installed per manufacturer's standards and specifications.
8. All hydrodynamic separators are to be Contech Engineered Solutions LLC, Cascade Separator. Sizing of the Cascade separators are to be per the

Drawings. Hydrodynamic Separators are to be installed per manufacturer's standards and specifications.

9. Underground detention system is to be constructed utilizing MC7200 StormTech chambers by Advanced Drainage Systems, Inc., or approved equal. Underground detention system is to be installed per Drawings and manufacturer's standards and specifications.

M. Mortar: Mortar shall meet the requirements of ASTM C270. Mortar shall be one part Portland cement and 2 1/4 parts washed mortar sand.

N. Preformed Flexible Joint Sealant: Preformed flexible joint sealant shall be EZ Stik, Kent Seal, Ram Nek, or equal, meeting the requirements of ASTM C990.

O. O Rings: O rings shall meet the requirements of ASTM C443.

2.3 BURIED PIPING

A. Ductile Iron Piping and Fittings:

1. Unless otherwise shown or specified, all underground piping 3 inches in diameter or larger shall be ductile iron conforming to AWWA C151/A21.51 with mechanical joints or push on joints. Pipe wall thickness shall be furnished as required by AWWA C150 for buried piping with the depth of cover as shown on the Drawings for laying condition 4, minimum Special Thickness Class or Pressure Class as listed below, unless otherwise shown or specified.

Pipe Size (Inches)	Pressure Class
3	350
4	350
6	350
8	350
10	350
12	350
14	250
16	250
18	250
20	250
24	250
30	250
36	250
42	250
48	250
54	250
60	250
64	250

2. Each pipe and fitting shall have the weight, class or nominal thickness, country where cast, casting period, manufacturer’s mark, the year in which

the pipe was produced, and the letters DI or DUCTILE cast or stamped thereon. Improper or incomplete marking will be cause for rejection of the pipe or fitting.

3. CONTRACTOR shall furnish certification data representing each class of pipe or fitting furnished. The certification report shall clearly state that all pipe and fittings furnished meet the appropriate AWWA specification. Ductile iron pipe shall consist of pipe centrifugally cast in metal or sand lined molds. Pipe wall shall be homogeneous from inside to outside and shall be completely free of laminations, blisters, or other imperfections. Defects may be removed at the factory only.
4. Except as otherwise specified, underground pipe shall have mechanical joints or push on joints conforming to AWWA C110 and C111, as well as AWWA C153 (compact), with vulcanized styrene butadiene rubber gaskets conforming to AWWA C111. Gaskets that include metal locking segments vulcanized into the gasket to grip the pipe and provide joint restraint are not acceptable. Underground hot water piping shall have EPDM gaskets designed for a minimum 212°F (mechanical joint and push on joint). Underground aeration piping shall have EPDM gaskets designed for a minimum 150°F (mechanical joint) or 200°F (push on joint). Underground aeration piping shall have FKM gaskets designed for a minimum of 300°F. Bolts on mechanical joints shall be high strength low alloy steel (Corten, or equal), conforming to AWWA C111. Certificate to that effect shall be provided.
5. Restrained joints shall be provided in accordance with Part 3–Execution. Mechanical joints shall be restrained with MEGALUG® Series 1100 or 1100 SD, by EBAA Iron Sales, Inc., UNIFLANGE Series 1400 by Ford Meter Box Co., Inc., or equal, restraint. Push on joints for ductile iron piping shall be restrained with MEGALUG® Series 1700 or 1100 HD, by EBAA Iron Sales, Inc., UNIFLANGE Series 1450 by Ford Meter Box Co., Inc., Flex Ring or Lok Ring by American Cast Iron Pipe Company, TR Flex by U.S. Pipe Company, TR Flex by McWane, or equal.
   a. Pipe restraint fittings shall be provided as follows:
      1) For ductile iron pipe with ductile iron mechanical joints MEGALUG® Series 1100 or 1100SD by EBAA Iron Sales, Inc.; Series D SLDE or SSLD by Sigma; Series 3000 or 3000S by Star Pipe Products; or equal.
      2) For ductile iron pipe with ductile iron push on joints MEGALUG® Series 1100HD or 1700 by EBAA Iron Sales, Inc; Series SLDEH or SSLDH by Sigma; Series 3100P or 3100S by Star Pipe Products; Flex Ring or Lok Ring by American Cast Iron Pipe Company; TR Flex by U.S. Pipe Company; or equal.
      3) For PVC pipe with ductile iron mechanical joint fittings–MEGALUG® Series 2000 PV, 1100SV, or 2000SV by EBBA Iron Sales, Inc.; Series D SLCE or PVM by Sigma; Series 1000C or 4000 by Star Pipe Products; or equal.
      4) For PVC pipe with PVC push on joints (not solvent welded)–MEGALUG® Series 1100HV, 1900, or 2800 by EBAA Iron Sales, Inc.; Series SLCEH, PWP (greater than 12 inch only), or D PWP (12 inches or less) by Sigma; Series 4100P by Star Pipe Products; or equal.
   b. Gland body, wedges, and wedge actuating components shall be ductile iron conforming to ASTM A536 Grade 65 45 12. Bolts and tie rods shall be high strength low alloy steel conforming to AWWA C111.

c. Gaskets that include metal locking segments vulcanized into the gasket to grip the pipe to provide joint restraint are not acceptable.

6. Joint restraint is not required for gravity sewers, drains, and those pipes designated in Paragraph 1. of 3.02.G. Infiltration/Exfiltration Tests. Joint restraint shall be provided for any pipe requiring pressure testing.
7. Underground pipe shall have mechanical joint or push on joint ductile iron fittings conforming to AWWA C110 and C111 or AWWA C153 compact fittings with a minimum rated working pressure of 150 psi. Gaskets for fittings shall be as specified for underground piping.
8. All ductile iron fittings shall be American Cast Iron Pipe, Tyler, U.S. Pipe, Clow, Griffin, or equal.
9. Ductile iron wall pipes shall be provided as shown on the Drawings. For piping over 24 inches that does not require restraints, wall pipes shall be provided with push on joint connection at exterior end of wall pipe. For piping over 24 inches that requires restraint, wall pipes shall be provided with Flex Ring or Lok Ring by American Ductile Iron Pipe Company, TR Flex by U.S. Pipe Company, TR Flex by McWane, or equal, connection. For piping over 24 inches, wall pipes may also be provided with mechanical joint connection at exterior end of wall pipe. For piping that requires restraint, mechanical joint connections at exterior end of wall pipe shall be restrained as specified for mechanical joints.
10. Unless otherwise specified, all exterior ductile iron piping and fittings shall be cement mortar lined and asphaltic coated inside. Cement mortar lining shall be in accordance with AWWA C104. Unless otherwise specified, underground piping and fittings shall be shop primed or asphaltic coated outside. Asphaltic coating shall conform to applicable standards herein for the pipe and fittings. Buried piping shall be coated with a layer of arc applied zinc per ISO 8179 Standard. The zinc applied shall be 200 g/m^2 of pipe surface area. A topcoat layer of asphaltic coating shall be applied per ANSI/AWWA C151 A21 51 Section 4.4 Coatings and Linings.
11. For buried pipe polyethylene encasement shall be V-BIO polyethylene encasement and shall meet ANSI/AWWA C105-A21.5 Polyethylene Encasement for Ductile Iron Pipe. V-BIO to include an anti-microbial Biocide as well as a corrosion inhibitor. Specifications to include 8 mil thickness, tensile strength of 3,600 psi per ASTM D882, elongation of 800% min per ASTM D882, and dielectric strength of 800 V/mil thickness per ASTM D149. Installation of V-BIO polyethylene encasement shall be per ANSI/AWWA C105-A21.5 Polyethylene Encasement for Ductile Iron Pipe.
12. Tapping and Bonding:
    a. In cases where corporation stops are to be tapped into mains, pipe wall thickness shall be furnished as specified in AWWA C151 to provide four threads or pipe saddles shall be furnished as approved by manufacturer.
    b. Cable bond conductor or electrobond conductivity straps shall be installed on all ductile iron piping to maintain electrical continuity across joints. Continuity across valves and fittings shall be made with multiple conductivity straps connected in series. Lead tipped gaskets or bronze wedges will not be allowed.
13. Cutting in and Repair Tees and Sleeves and Tapping Tees: Cutting in and repair tees and sleeves and tapping tees shall be of ductile or cast iron with the same rated working pressure of the pipe in which they are installed but no less than 150 psi.

14. Exterior Joints, Fittings, and Gaskets: Joints, fittings, and gaskets shall have the same rated working pressure of the pipe in which they are installed but no less than a minimum rated working pressure of 150 psi.

B. Solid Wall PVC Sanitary Sewer:
1. Polyvinyl chloride (PVC) pipe shall meet the requirements of ASTM D3034 for pipe sizes 4 inches through 15 inches and ASTM F679 for pipe sizes 18 inches through 60 inches.
2. PVC material for ASTM D3034 pipe shall have cell classification 12454 or 12364 as defined in ASTM D1784 with minimum modulus of elasticity of 400,000 psi. Pipe stiffness shall be minimum 46 psi when tested in accordance with ASTM D2412. Pipe shall have a maximum standard dimension ratio (SDR) of 35.
3. PVC material for ASTM F679 pipe shall have cell classification 12454 or 12364 as defined in ASTM D1784 with a minimum modulus of elasticity of 500,000 psi. Pipe stiffness shall be a minimum 115 psi when tested in accordance with ASTM D2412.
4. Pipe and fittings shall be the product of one manufacturer, and the manufacturer shall have experience records substantiating acceptable performance of the pipe and fittings to be furnished. The minimum wall thickness of fittings shall be the same as the pipe to which it connects.
5. Acceptance of piping and fittings shall be subject to tests conducted in accordance with ASTM D3034 and/or ASTM F679.
6. Fittings such as saddles, elbows, tees, wyes, and others shall be of material and construction corresponding to and have a joint design compatible with the adjacent pipe. Approved adapters shall be provided for transitions to other types of pipe.
7. Joints shall be of the elastomeric type for pipes 4 inches or larger and elastomeric or solvent cement for pipes less than 4 inches.
8. Elastomeric joints shall be a bell and spigot joint conforming to ASTM D3212 sealed by a rubber gasket conforming to ASTM F477 so that the assembly will remain watertight under all conditions of service, including the movements resulting from the expansion, contraction, settlement, and deformation of the pipe. Bells shall be formed integrally with the pipe and shall contain a factory installed positively restrained gasket.
9. Solvent cement joints shall be assembled using solvent cement obtained from the pipe manufacturer, which conforms to the requirements of ASTM D2564.
10. The assembled joint shall pass the performance tests as required in ASTM D3212.

C. Gravity Sanitary Sewer Service Branches and Laterals:
1. Branches (tees and wyes) shall be of the same material as the main except for reinforced concrete pipe used for sanitary sewer. For reinforced concrete pipe, special branches shall be furnished and installed to accept the lateral. Such special branches are subject to review by ENGINEER.
2. If a different thermoplastic material is specified for laterals than for the main line, appropriate solvent welds, fittings, transition couplings, and other appurtenances shall be provided to effect a water tight seal.
3. Fittings for laterals shall be of the same material as the lateral pipe unless special fittings are needed for transition between material types or sizes or standard fittings are not manufactured.

4. Where the wye or tee branches and laterals are of dissimilar materials, CONTRACTOR shall provide a transition coupling for the connection.
5. All fittings used, including type of jointing, are subject to review by ENGINEER.

D. PVC Pipe (AWWA) and PVC Pressure Pipe Fittings (4 Inches and Larger):
1. PVC Storm sewer where shown on the Drawings shall be AWWA PVC pressure rated pipe and shall conform to the requirements of AWWA C900 for pipe from 4 inches to 60 inches. Pipe shall be furnished with integral elastomeric bell and spigot joints.
2. PVC pipe diameter shall conform to ductile iron pipe sizes (DIPS). The type of PVC material, nominal pipe size, standard dimension ratio, and pressure class shall be not less than pressure class 235 and not greater than pipe dimension ratio 18.
3. Markings on pipe shall include the following: Nominal pipe size, type of plastic pipe material, DR number, AWWA Designation with which the pipe complies, manufacturer's name, and the seal or mark of the laboratory making the evaluation of the suitability of the pipe for transport of potable water.
4. All fittings for PVC pressure pipe shall be iron pipe fittings as specified herein.
5. Provide tracer wire for underground PVC piping as specified herein, unless otherwise noted.

E. Composite Pipe (PVC and ABS):
1. Composite pipe shall meet the requirements of ASTM D2680. Resin used in the manufacture of PVC composite sewer pipe and fittings shall have cell classification 12454 as defined in ASTM D1784. Resin used in the manufacturer of ABS composite pipe and fittings shall have cell classification of 1 0 2 2 3 of ASTM D3965.
2. Acceptance of piping shall be subject to tests conducted by an approved testing agency.
3. Attachment of couplings and saddle fittings and field joining of pipe sections and fittings shall be accomplished by solvent welding or rubber gaskets in accordance with the recommendations of the pipe manufacturer. All exposed filler material shall be field coated with ABS or PVC Solvent Cement. Approved adapters shall be provided for transitions to other types of pipe.
4. Pipe shall be subject to rejection for failure to conform to material requirements of ASTM D2680 or for any of the following reasons:
   a. Distortion or puncture of the inner plastic shell. Distortion or punctures of the outer shell shall not be reasons for rejection if the inner shell is unaffected and such exterior distortion or puncture is suitably repaired with a solvent welded patch.
   b. Voids in the concrete filler at pipe ends, exceeding 1 inch in depth as measured from the pipe end and exceeding 10% of the pipe circumference. However, this pipe may be used if the faulty pipe end is sawed off and field coated.
   c. Through cracks in coupling.

F. HDPE Corrugated Pipe:
1. HDPE Corrugated pipe to be Advanced Drainage Systems, Inc. N-12 pipe, or approved equal.

2. Fittings may be molded or fabricated and shall not impair the integrity or function of the pipe. Only fittings supplied or recommended by pipe manufacturer shall be used. Where elastomeric gaskets are required, they shall conform to ASTM F477.

G. HDPE Pipe and Fittings for Stormwater Sewer:
1. HDPE pressure rated pipe shall conform to the requirements of AWWA C906 for pipe from 4 inches through 65 inches. HDPE pipe shall be manufactured from material conforming to PE Code PE4710.
2. HDPE pipe outside diameter shall conform to ductile iron pipe sizes (DIPS). The type of HDPE material, nominal pipe size, standard dimension ratio, and pressure rating shall be not less than pressure class 250 and not greater than a dimension ratio (DR) 9.
3. Markings on the pipe shall include the following: Nominal pipe size, type of plastic pipe material, DR number, pressure class rating, manufacturer's name, and the seal or mark of the laboratory making the evaluation of the suitability of the pipe for the transport of potable water.
4. Fittings for HDPE pipe shall conform to AWWA C906 and shall have the same pressure rating as the pipe in which they are installed.

H. Perforated Piping Stormwater Sewer :
1. Perforated pipe and fittings shall be heavy duty corrugated polyethylene conforming to ASTM F405 and ASTM F667. Pipe and fittings shall be provided as shown on the Drawings and in accordance with ASTM F449.
2. Adapters with band seals shall be provided when joining with pipe of different materials.
3. Pipe shall be as manufactured by Advance Drainage Systems, Inc., Hancor, Inc., or equal.
4. See detail on Drawings for laying conditions.
5. Fabric shall be provided in accordance with manufacturer's instructions. Minimum lap shall be 18 inches. All laps shall be tacked or pinned to prevent separation during installation.

I. Transition Couplings for Gravity Sewer Service: Transition couplings shall be provided to join dissimilar pipe materials or to connect pipe where a standard pipe joint cannot be provided. Couplings shall be designed to join the pipe materials matching flow line elevations. Transition couplings for gravity sewer service shall be Fernco 5000 RC Strongback, Mission Flex Seal ARC Shielded, or equal. Shear rings shall be provided to minimize differential settlement. All bands, clamps, shear rings and other metal components shall be stainless steel. Bushings or transitions shall be provided to accommodate pipe size differences.

J. Miscellaneous Pipe:
1. Piping needed for repair or reconstruction of existing utilities and appurtenances shall be of the same type and strength as the existing. The type of jointing used in repair and reconstruction shall be reviewed by ENGINEER. Special fittings shall be furnished and installed as necessary for repair, reconstruction, or connection of existing facilities.
2. All special fittings on or for connection to utilities shall be specifically built for the type of gasket used. Special fittings shall have joints of the same type as the utility to which the connection is being made.

3. When sanitary sewer construction is within 50 feet of a potable well, 200 feet of a municipal well, or as requested by ENGINEER, a water main equivalent pipe shall be used. To transition from water main equivalent pipe to pipe normally supplied, a transition pipe with suitable joints to mate the two different pipes shall be supplied. No field constructed transitions will be allowed unless reviewed by ENGINEER and approved by OWNER. Construction shall not proceed until proper transition pipe is supplied.

K. Tracer Wire:
1. Provide minimum 10 gauge solid insulated copper tracer wire with buried thermoplastic pressurized pipe. Wire shall be continuous, terminate, and be accessible at valve boxes, manholes, fire hydrants, or at test stations as specified below. Tracer wire shall be located 12 inches above the top of the pipe. Any splices in copper wire shall be made with a 3MTM DBR/Y 6 splice kit, or equal.
2. Tracer wire test stations shall be SnakePit magnetized tracer boxes by Copperhead Industries, or equal. Tracer box shall be corrosion resistant brass wire lugs and wax pad to cover wire connection. Cover shall be color coded according to APWA standards for fluid conveyed. Provide SnakePit Lite Duty Box in unpaved areas and Roadway Box in paved areas. Provide Rhino Triview Marker Posts, or equal, at all test stations. Provide custom decals to identify fluid in piping. The tracer wire shall be accessible at a minimum of every 500 feet along the pipeline and at horizontal bends in piping. The tracer wire shall run into and up the sides of all manholes and be secured near the casting. Test stations shall be placed as required between manholes to comply with the minimum 500 foot tracer wire accessibility requirement.
3. CONTRACTOR shall perform continuity testing of all tracer wire in the presence of OWNER ENGINEER.

2.4 VALVES (VALVES FOR UNDERGROUND SERVICE ARE SPECIFIED IN DIVISIONS 23 AND 40)

A. Valves shall conform to Section 40 05 00–Piping and Appurtenances.

B. Gate Valves:
1. Shutoff valves in cast or ductile iron lines containing potable and non potable water lines 4 inch diameter and larger shall be AWWA C515, ductile iron AWWA C509, cast iron, resilient seat, nonrising stem, OS&Y (rising stem) for wastewater applications, 150 psi working pressure with O ring packing box, Kennedy, American, American AVK, or equal.
2. Where shown or specified, gate valves in lines 4 inches in diameter or larger shall be AWWA C500 iron body, bronze mounted, nonrising stem, double disc, parallel seat, Class 150, O ring stem seals.

C. Corporation Stop and Curb Stop Valves:
1. Performance Requirements: Lead Free Requirements: All materials that contact potable water shall be lead free. Lead free refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per the Federal Safe Drinking Water Act as amended January 4th, 2011 Section 1417. All products used in potable

water systems shall be UL classified in accordance with ANSI/NSF 61 for potable water service and shall meet the low lead requirements of NSF 372.

2. Corporation Stop Valves: 2 Inches and smaller: Bronze body ground key valve, bronze plug, AWWA taper thread inlet and copper flare outlet nut connections or compression type, AWWA C800.
3. Curb Stop Valves: Boxes 2 Inches and smaller: Bronze body plug valve, bronze plug, quarter turn check, O ring seals, copper flare nut connections or compression type, AWWA C800. Provide Minneapolis type curb box complete with lid and stationary rod.

2.5 FIRE HYDRANTS

A. Fire hydrants provided under these Standard Specifications shall conform to AWWA C502 for Dry Barrel Fire Hydrants. Hydrants shall have the following features:

Bury Length	Approximately 7 1/2 feet to traffic flange.
Nozzle Size	One 4 1/2-inch- and two 2 1/2-inch-diameter openings.
Nozzle Threads	National standard fire hose coupling screw threads.
Drain Port:	Drain port at base of hydrant barrel. Plug drain port when hydrant installed in area where groundwater level may rise above drain port.
Size of Main Valve Opening	5 1/4-inch-diameter minimum. The hydrant lead connection shall be minimum 6-inch-diameter mechanical joint.
Torque Requirements	Hydrant shall comply with AWWA C502 even if greater than 5-foot bury.
Lubrication	Nontoxic and providing proper lubrication for a temperature range of -30°F to +120°F.

B. Hydrants shall have permanent markings identifying the manufacturer by name, initials, insignia, or abbreviations in common usage, and designating the size of the main valve opening and the year of manufacture. Markings shall be so placed as to be readily discernible and legible after hydrants have been installed.

C. CONTRACTOR shall furnish certification to ENGINEER that the hydrant and all material used in its construction conform to the applicable requirements of AWWA C502 and the supplementary requirements thereto.

D. All joints on fire hydrant leads shall be made using pipe restraint specified herein. Approximately 1/2 cubic yard of bedding stone shall be placed from the bottom of the trench around the hydrant elbow and up the hydrant barrel. Bedding stone shall be wrapped completely in filter fabric to prevent the in migration of fine materials.

E. CONTRACTOR shall furnish all necessary fittings in the fire hydrant lead to install the fire hydrant in a plumb condition at locations shown on the Drawings and at the specified depth of bury. The pumper nozzle of all fire hydrants shall be installed with the nozzle pointing toward the street. ENGINEER reserves the right to alter the location of fire hydrants from that shown on the Drawings.

F. Hydrants shall be installed as shown on the Drawings.

G. Fire Hydrant:
   1. Fire hydrant shall be Waterous W 67 Pacer, or equal
   2. Hydrant to be painted yellow.
   3. Provide restrained joint system from auxiliary valve in road box back to tee.
   4. Connect hydrant to auxiliary valve with 2 foot length of pipe.
   5. Provide drain port at base of hydrant barrel. Plug drain port when hydrant installed in area where groundwater level may rise above drain port.

2.6 CONCRETE

A. All concrete poured under this Contract, unless shown or specified otherwise, shall conform to the requirements of Division 03.

2.7 AGGREGATE SLURRY (FLOWABLE) BACKFILL

A. Aggregate slurry (flowable) backfill shall consist of fine and coarse aggregate conforming to ASTM C33. Coarse aggregate shall be size number 67 and fine aggregate shall be size number 4. The material shall be mixed with water to provide an approximate 3 inch slump. The mix shall be deposited in the trench from ready mix concrete transit mix trucks and shall be consolidated using concrete vibrators or vibratory plate compactors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Underground Piping:
   1. Utility lines shall be laid and installed to the lines and grades specified with valves, fittings, manholes, and other appurtenances at the specified locations; spigots centered in bells; and all manholes and riser pipes plumb. Water main and force main shall be installed at the depth indicated. Water main, force main, and other pressure mains shall be installed to within (plus or minus) 0.1 feet of designed grades. Sanitary and storm sewer and laterals shall be installed to within (plus or minus) 0.03 feet of designed grades. Service lines shown on the Drawings are approximate. Existing utilities shown on the Drawings are approximate. Staking shall be completed in conformance with Division 01 of the Standard Specifications.
   2. Deviations Occasioned by Underground Facilities: Wherever significant obstructions not shown on the Drawings are encountered during the progress of the Work, CONTRACTOR shall proceed in accordance with the General Conditions to notify owners and protect the facilities. Existing items unnecessarily damaged during the performance of the Work shall be repaired and replaced at the expense of CONTRACTOR.
   3. Prior to commencing pipe laying, CONTRACTOR shall notify ENGINEER of the intended date for starting Work. ENGINEER may request at CONTRACTOR's expense the removal and relaying of pipe which was installed prior to notification of ENGINEER.

a. Proper implements, tools, and facilities shall be provided and used by CONTRACTOR for the safe and convenient prosecution of the Work. All pipe, fittings, and appurtenances shall be carefully lowered into the trench piece by piece with a crane, rope, or other suitable tools or equipment, in such manner as to prevent damage to materials. Under no circumstance shall pipe be dropped or rolled into the trench.

b. Materials shall be as shown on the Drawings or as specified herein.

4. Material Inspection: CONTRACTOR shall inspect the pipe, fittings, and appurtenances for defects when delivered to the jobsite and prior to lowering into the trench. Defective material shall be removed from the jobsite. All material shall be clean and free of deleterious substances prior to use in the Work.

5. Except where noted or specified, all ductile iron underground piping shall be laid in accordance with AWWA C600 or AWWA C605 with the conditions that (a) blocking shall not be used to support pipe and (b) all bends and fittings shall be restrained as specified below, and pipe joints shall be restrained in all directions from all bends and fittings to the length as specified below.

6. Pipe Length: The minimum length of pipe to be restrained shall be as shown in the following table.

7. For restrained pipe joints, all underground ductile iron pipe joints (except for the branch of tees and dead ends) shall be restrained to the length listed below in all directions from all bends and fittings. The branch of tees shall be restrained to two three=Kentucky times the length listed below. Dead ends shall be restrained to 2.5 3.5=Kentucky times the length listed below. All joints on yard and fire hydrant leads shall be restrained. Where wall penetrations occur at less than the length indicated below, the wall fittings shall also be restrained. Additional restraint shall be provided inside of structures as required.

MINIMUM LENGTH (IN FEET)
RESTRAINED PIPE FROM BENDS OR FROM BENDS OR FITTINGS
(POLYWRAPPED AND MINIMUM 6 FEET 4 FEET=OHIO
3 FEET=KENTUCKY BURY DEPTH)

	Test Pressure, psi				
	10	25	50	100	150
Pipe Size, Inches					
3 to 12	5	18	18	36	36
14 to 18	5	18	18	36	54
20 to 24	5	18	36	54	72
30	10	18	36	72	90
36	10	18	36	72	
42	10	36	54	90	
48	10	36	54	90	

8. Force main and water main shall be installed in accordance with AWWA C600 for iron pipe, AWWA C605 for PVC pipe. All plugs, caps, tees, hydrants, bends, and other fittings for water mains and force mains shall be provided with restrained joints.

9. PVC sewer and plant drain piping shall be installed in accordance with ASTM D2321. Except where noted or specified, PVC or other thermoplastic pressure piping shall be installed in accordance with ASTM D2774.

10. Except where noted or specified, reinforced concrete pipe shall be installed in accordance with ASTM C12.
11. CONTRACTOR shall lay all gravity pipe to the line and grade shown on the Drawings with bell ends uphill wherever possible. If not possible, CONTRACTOR shall lay pipe to the line and grade shown on the Drawings with bell ends in the direction of laying. Water piping shall have a minimum 48-IN of cover.
12. Any pipe or fittings cracked in cutting or handling or otherwise not free from defects shall not be used. Pipe must be kept clean of mortar, cement, clay, sand, or other material. When PVC piping is installed during hot weather, it shall be laid in the trench with slack or permitted to cool to ground temperature before it is cut to length for making final connections. PVC expansion joints shall be provided where needed.
13. At times when pipe laying is not in progress, the open ends of pipe shall be closed with plugs to prevent the entry of foreign material. Acceptable plugs include Foreman Nite Caps by APS, mechanical joint cap or plug, bladder plug, or test plug. All foreign material shall be removed from the pipe prior to acceptance.
14. The locations and elevations of existing piping and manholes are approximate. Where necessary, existing piping shall be exposed by CONTRACTOR to confirm location and elevation before installing new piping. Any changes in pipe location or elevation shall be approved by OWNER.
15. General Excavation:
    a. Pipe Laying:
        1) All pipe shall be laid accurately to the line and grade as designated. Preparatory to making pipe joints, all surfaces of the portions of the pipe to be joined or of the factory made jointing material shall be clean and dry. Lubricants, primers, adhesives, and other joint material shall be used and installed as recommended by the pipe or joint manufacturer's specifications. The jointing materials or factory fabricated joints shall then be placed, fitted, joined, and adjusted in such a workmanlike manner as to obtain the degree of watertightness specified. Pertinent specifications from the joint and pipe manufacturer which outline procedures to be followed in making the joint shall be furnished to ENGINEER.
        2) Wyes, tees, and special fittings shall be installed as called for on the Drawings, or as requested by ENGINEER. Wyes, tees, and special fittings, shall, in general, be jointed with the same type of joint as used in the pipe.
        3) In joining two dissimilar types of pipe, manufactured adapters and fittings shall be used. Adapters and fittings shall be configured to maintain invert elevations at same level.
        4) Joint deflections shall not exceed the limits established by the pipe manufacturer for the pipe and joint being used.
        5) Joints that are damaged because of carelessness, improper handling, or failure to prevent imperfections in manufacture shall be subject to rejection and gaskets shall be subject to rejection whenever they show surface cracking, tears, or splice separation.
        6) At times when pipe laying is not in progress, the open ends of pipe shall be closed with plugs to prevent the entry of foreign material.

All foreign material shall be removed from the pipe prior to acceptance.

7) After placing a length of pipe in the trench, the spigot end shall be centered in the bell and the pipe forced home and brought to correct line and grade. The pipe shall be secured in place with specified backfill material tamped around it except at the bells.

8) Pipe shall be brought home by using a cross member and levers or jacks. It will not be permissible to push pipe home with motor powered excavation equipment.

9) Water main shall be installed in accordance with AWWA C600 for iron pipe, AWWA C605 for PVC pipe, and AWWA M55 for HDPE pipe. All plugs, caps, tees, hydrants, bends, and other fittings for water mains and force mains shall be provided with restrained joints.

b. Sewer Service Branch and Lateral Installation:

1) CONTRACTOR shall furnish and install sanitary sewer and storm sewer branches, laterals, and leads as shown on the Drawings or requested by ENGINEER. Under normal circumstances, service laterals will be installed within the right of way or easement to serve all existing buildings and all platted lots. In certain cases, only wye or tee branches will be installed to vacant lots. Service laterals shall consist of a branch fitting at the main and extension of the specified lateral pipe to the end of lateral as called for and requested. All necessary fittings shall be furnished and installed to complete the installation as shown on the Drawings. All necessary fittings shall be furnished and installed to complete installation of storm sewer leads as shown on the Drawings.

2) Wye or tee branches: Wherever shown on the Drawings or requested by ENGINEER, wye or tee branches shall be provided for use in making sanitary sewer service and storm sewer inlet connections. Unless specified otherwise on the Drawings, wye or tee branches for sanitary sewer service lateral connections to single family residences shall be 4 inch diameter. All other sanitary sewer service lateral connections shall be 6 inches. Wye or tee branches for storm sewer inlet connections shall be of the size called for on the Drawings, 12 inches minimum.

3) Sanitary sewer service branches shall be turned so that the branch is at an angle of 30 degrees or 45 degrees from the horizontal.

4) Sanitary Sewer Service Laterals: Under normal conditions and unless otherwise shown on the Drawings or requested by ENGINEER, all service laterals shall be Standard Laterals, Type 1, as shown on the Drawings. Service laterals of Types 2 through 6 may be requested by ENGINEER to meet field conditions.

5) It is the general intent to install Modified Laterals, Type 2, 4, or 5 for service to homes that presently have shallow or no basements or where the depth to groundwater at the end of lateral is shallow. Types 3 and 6 risers are only to be provided where shown on the Drawings.

6) Installation and Testing Requirements: Except for those branches that are to be used on storm sewers or for extending sanitary sewer service laterals, wye and tee branches shall be closed with airtight stoppers blocked to withstand air test pressures.

7) The ends of all laterals shall be plugged and blocked to resist air test pressures. All plugs shall be manufactured to fit the pipe used and shall be watertight. The ends of all laterals shall be marked as shown on the Drawings using flagging tape and 2 by 4 markers.

8) Unless otherwise provided for in the Drawings, each service lateral shall have a tracer wire installed from the main to the property line or the location of the connection to the existing service, whichever is greater or applicable. The tracer wire shall be 10 gauge solid copper with no splices. The wire shall be secured to the pipe with duct tape at a minimum of 3 foot intervals. The ends of the tracer wire shall be brought to the ground surface and stored in an access terminal box, DWS–Tracer Wire Access Box, or equal, at a location selected by OWNER. Eighteen inches of additional wire length shall be coiled at the location of the terminal box. CONTRACTOR shall confirm the method of installation is compatible with OWNER's means of detecting the location of the service lateral. Each tracer wire shall be tested by CONTRACTOR to confirm it accurately provides the location and depth of the sewer lateral.

9) A complete and accurate tabulation of length, depth, and location of all branches, risers, and laterals shall be kept by CONTRACTOR on cards available from ENGINEER. Measurements shall be made from the nearest downstream manhole. Lateral installation to meet these Standard Specifications and field conditions are the responsibility of CONTRACTOR. Problems occurring because of failure to provide proper installation or proper records shall be corrected by CONTRACTOR at its expense.

10) No installed lateral shall be backfilled until ENGINEER has been notified that the lateral is complete and reasonable time is allowed for observation of the Work.

c. Water Service Lateral Installation:

1) Water service laterals requiring reconstruction and new service laterals shall be installed in accordance with AWWA C600. CONTRACTOR shall perform all excavation, backfill, and other Work necessary for a complete installation. The service tubing shall be continuous and shall be placed at a minimum depth of 6.5 feet. Each service shall include a corporation stop at the main, copper service tubing, curb stop, curb box, couplings, and all other appurtenances necessary for a complete installation. Where existing services in the street are being reconstructed, the new service shall be connected to the existing service at the property line unless otherwise shown or specified. Taps in the main shall be at an angle of 45 degrees above the horizontal.

2) OWNER reserves the right to make taps and connections to the new mains prior to backfilling by CONTRACTOR. CONTRACTOR shall delay backfilling until OWNER has completed its Work.

3) All curb boxes on new services shall be marked by placing a 4 foot long 2 by 4 adjacent to it. The 2 by 4 shall project 1 foot above existing ground and shall be painted blue. All services shall be extended to the street property line, unless otherwise shown or specified.

d. Manholes:

1) Manholes shall be installed in accordance with the Drawings for water main, and Drawing 01 975 43A for sanitary sewer. Manholes shall be plumb with any steps aligned and openings located over steps. For sanitary sewers, openings shall be located over the bench and not the sewer flow line itself.
2) All manholes shall be made watertight and shall show no visible signs of leakage at the time of final review and within the correction period. Any leakage shall be sealed from the exterior of the manhole.

e. Storm Sewer Inlets:
1) Storm sewer inlets shall be installed in accordance with the Drawings. Inlets shall be set to the line and grade as furnished by ENGINEER. The outside end of the lift hole shall be covered with filter fabric to prevent the entrance of fines into the inlet.
2) Inlets shall be connected to the storm sewer main either at manholes or to other inlets, all as shown on the Drawings. Minimum size of inlet lead pipe shall be 12 inches.
3) Storm inlets shall be backfilled to undisturbed soil and at least 2 feet along connecting piping with bedding material.

f. Masonry:
1) No masonry shall be laid when the temperature of the outside air is below 40°F unless all masonry materials are heated and protected against freezing.
2) Only enough mortar shall be mixed that can be conveniently used before it reaches initial set. Retempering of mortar will not be permitted.

g. Abandoning Utilities: Utilities to be abandoned shall, unless otherwise noted on the Drawings, be abandoned in place. Open ends of pipes shall be plugged with 12 inches of concrete. Manhole barrels, valve boxes and other such structures shall be removed to a point 3 feet below existing or final ground surface, whichever is lower, and shall then be filled with backfill material compacted to that of the trench backfill. An approximate 9 inch diameter opening shall be made in the bottom of the structure to allow for groundwater movement.

h. Connections to and Modifications of Structures and Mains:
1) Unless otherwise noted on the Drawings, openings in existing structures to allow for connection of mains shall be core drilled, and the mains themselves shall be connected by use of watertight connections as specified in the Standard Specifications. Flow channels in the bottoms of existing structures shall be modified as necessary to provide smooth transition for incoming flow and/or orientation of mains. These modifications may include breaking out and reforming flow channels.
2) Where mains, new and existing, are to intersect, dog house manholes shall be provided to facilitate connection and to gain access to the intersecting mains. Manholes shall be provided at the manufacturing plant with arched openings in lower barrel section to span each of the intersecting mains. Reinforcing shall be cut and bent back. In the field, manhole shall be set on concrete blocks, with reinforcing provided according to the Drawings for the bottom slab. Concrete shall be poured under and around the manhole to seal all openings, cover and adhere to the slab and

bent reinforcement, and provide for benches or fillets in the manhole. Sanitary and storm sewer mains shall be kept intact until the bench or fillet is poured. Then the top of pipe to springline shall be removed to provide access.

16. Valve Boxes: The valve box shall be centered and plumb over the wrench nut of the valve with the box cover flush with the finished ground elevation. Solid 4 inch concrete blocks shall be placed under the base of valve boxes so that the bottom of the base is about 2 inches away from contact with the valve bonnet. The valve box shall not transmit shock or stress to the valve.

3.2 FIELD QUALITY CONTROL

A. CONTRACTOR shall include the cost of all televising, testing, cleaning, and disinfection in the price bid.

B. Work shall be tested as specified in this section. Unless indicated in writing before testing begins, tests shall be witnessed by ENGINEER and others as necessary. Test results shall be recorded, and reports or appropriate certificates shall be submitted to ENGINEER in triplicate.

C. New piping shall be tested. Prior to conducting the pressure and leakage test, CONTRACTOR shall backfill the trench for its full depth. All bends and special connections to the main shall be adequately blocked and tied prior to the test. Any damage caused to the main or its appurtenances during performance of these tests shall be corrected by CONTRACTOR at its expense. Should underground piping fail test, CONTRACTOR shall be responsible for removal and replacement of backfill, and relay new pipe if necessary, to repair the defective pipe. Under no circumstances shall defects be sealed from the interior of the pipe, and only where specifically allowed by ENGINEER, shall defects be sealed from the exterior of the pipe. Piping, interior or exposed, shall be subject to test before being covered with insulation or paint. Piping and appurtenances shall be watertight or airtight and free from visible leaks. Manholes and precast reinforced concrete wet wells and appurtenances shall be free of any visible leaks. Any leakage shall be sealed by methods acceptable to OWNER, from the exterior of the manhole or structure. Precast reinforced concrete manhole risers and tops shall be tested in accordance with ASTM C497.

D. Piping shall be flushed or blown out after installation prior to testing. CONTRACTOR shall provide all necessary piping connections, water, air, test pumping equipment, water meter, bulkheads, valves, pressure gauge and other equipment, materials, and facilities necessary to complete the specified tests. CONTRACTOR shall provide all temporary sectionalizing devices and vents for testing.

E. Pressure Tests:
1. Pressure tests shall be performed as required by AWWA C600 and AWWA C605, unless otherwise noted herein.
2. When test medium for piping is water, all air shall be removed from piping by flushing, opening vents, loosening flanges, utilizing equipment vents and/or installation of corporations at high points in system. Test pumping equipment used shall be centrifugal pumps or other pumping equipment that will not place shock pressures on the main. Power plunger pumps will not be

permitted for use on closed pipe systems. Pumps shall be disconnected during test periods. Presence or absence of air will be determined during pressurization of the piping system.

3. The test pressure in all lines shall be held for one hour during which time the leakage allowance shall not exceed that specified. In case repairs are required, the pressure test shall be repeated until the pipeline installation conforms to the specified requirements. Pumps, air compressors, instrumentation, and similar equipment shall not be subjected to the pressure tests. All piping conveying a combination of fluids, such as SCM/WAS, shall be tested at the higher test pressure.
4. During performance of the hydrostatic pressure test, water main shall be subjected to a minimum pressure of at least 50% above normal working pressure with a minimum pressure 125 psi. Force main shall be tested to 200% of normal operating pressure in the main, but to no more than the pressure rating of the pipe.
5. CONTRACTOR shall keep a record of all tests performed. These records shall show the individual lengths of main tested and test results.
6. Where connections are made to existing mains, it shall be the responsibility of CONTRACTOR to provide the necessary hydrostatic tests on all new mains installed. This may necessitate, but is not limited to, the installation of temporary valves and restraint to isolate the new system from the existing system. All materials, Work, and equipment necessary for this Work shall be furnished by CONTRACTOR at its expense.
7. All testing of pipelines shall proceed concurrently with installation. CONTRACTOR is advised that it may be advantageous to conduct daily preliminary testing of its Work.
8. Water from disinfection testing shall not be discharged to a stream, creek, river, storm sewer tributary thereto, or to a navigable water without first neutralizing the chlorine residual in the water and complying with local, state, and federal laws thereto.
9. Gauges used for testing shall have increments as follows:
    a. Tests requiring a pressure of 10 psi or less shall use a testing gauge having increments of 0.10 psi or less.
    b. Tests requiring a pressure of greater than 10 psi by less than or equal to 100 psi shall use a testing gauge having increments of 1 psi or less.
    c. Tests requiring a pressure of greater than 100 psi shall use a testing gauge having increments of 2 psi or less.

F. Prior to making final connection between new and existing piping, new piping shall be tested as specified above.

G. Infiltration/Exfiltration Tests:
1. Leakage Testing:
    a. All sanitary sewer gravity mains, drains, and those pipes designated as PSS, PRF, RW, and D shall be tested for leakage after installation of laterals and placement of backfill. Leakage testing of thermoplastic and iron sanitary sewer gravity mains shall be conducted in accordance with ASTM F1417. Testing of clay sanitary sewer mains shall be in accordance with ASTM C828. Testing for concrete sanitary sewer mains shall be in accordance with ASTM C1214. CONTRACTOR shall keep a record of all tests performed. These records shall show the individual lengths of main tested and test results.

b. Sewers 18 inches and larger may be tested for leakage by infiltration or exfiltration in lieu of vacuum testing. Concrete pipe shall be tested per ASTM C969 except as modified herein. If groundwater is 2 feet or more above the sewer, measurements will be taken to determine the rate of infiltration into the sewer. If groundwater is below 2 feet above the sewer, the stretch of sewer shall be plugged at its downstream end and water shall be placed inside the sewer to provide a minimum of 4 feet of head above the upstream end.

c. Measurements will then be taken to determine the rate of leakage out of the sewer. CONTRACTOR shall furnish all labor and materials necessary for making the tests. The allowable leakage shall be as indicated below for final acceptance.

d. At the conclusion of construction and before final acceptance of the Work, the downstream end of all sanitary sewer will be measured for infiltration. Allowable infiltration shall not exceed 100 gallons/inch of pipe diameter/mile/day for that portion of the Work under groundwater. If infiltration is exceeded, the leak or leaks shall be located and repaired.

e. CONTRACTOR shall prepare all pipeline for testing and shall furnish all equipment, materials, tools, and labor necessary for performance of the tests. Equipment for the low pressure air test of gravity mains shall be equal in all operational aspects to that as furnished by Cherne Industries, Inc., United Survey, or equal.

f. Test apparatus and gauges shall be located such that ENGINEER or OWNER do not have to enter a confined space to verify readings.

g. Air and leakage testing of storm sewers will not be required.

2. Deflection Testing:

a. All PVC pipe used for sanitary sewer shall be tested for vertical deflection. Maximum deflection after completion of backfilling shall be 5% of the inside pipe diameter. Testing shall not be started until trench backfill has been in place for 30 days. CONTRACTOR shall keep a record of all tests performed. These records shall show the individual lengths of main tested and test results. Deflection shall be measured by pulling a mandrel with a vertical diameter equal to 95% of the pipe inside diameter through the line, after thoroughly flushing the lines to be tested. The testing device shall be controlled using cables at both the upstream and downstream manholes. The testing device must pass freely through the sewer without the use of unreasonable force on the control cables. Any line that will not pass the test cylinder will not be accepted until the faulty sections have been removed and replaced and the line retested.

b. Deflection testing of thermoplastic storm sewer shall be provided in accordance with the above requirements.

H. Manhole Testing:

1. Sanitary sewer and process piping manholes shall be vacuum tested in accordance with ASTM C1244. Pipes entering the manhole shall be plugged and the seal inflated in accordance with manufacturer’s recommendations. CONTRACTOR shall provide all required test apparatus, including vacuum pump and gauges.

2. Vacuum testing of storm sewer and other manholes will not be required.

I. Televised Inspection: A color televised survey of installed sanitary sewer and storm sewer shall be provided after testing to confirm branch locations, verify cleanliness of sewer, and confirm presence or absence of sags or deviations in sewer alignment. Sewers shall be cleaned immediately prior to the survey. The survey shall conform to NASCO PACP standards.

J. Continuity Testing: CONTRACTOR shall provide all equipment, labor, and materials necessary to perform continuity testing of all ductile iron water mains installed. Tests shall be performed using an ohmmeter to demonstrate that electrical continuity exists across all joints. CONTRACTOR shall make all necessary repairs to establish continuity across joints.

3.3 CLEANING AND DISINFECTION

A. All equipment and materials shall be clean before installation. CONTRACTOR shall disinfect and flush the potable water system before it is put online. Water main shall be disinfected according to AWWA C651.

B. In accordance with the requirements of AWWA C651, at least one set of samples shall be collected from every 1,200 feet of new water main, plus one set from the end of the line and at least one set from each branch.

C. CONTRACTOR shall obtain water samples and arrange for analysis of water in potable systems for bacteria in accordance with Option A of Section 5.1 of AWWA C651. Copies of test results shall be submitted to OWNER and ENGINEER.

D. CONTRACTOR shall furnish all water and other materials, equipment, and labor necessary to disinfect all new water mains and all existing water mains disturbed by construction. CONTRACTOR shall notify the Health Department to observe disinfection test and shall coordinate and bear cost for necessary laboratory testing and shall provide safe bacteriological sample results to OWNER prior to placing the water main in service. Sampling and testing shall be scheduled to complete the Work within the Contract Times. Items of material for testing shall be furnished in the size and quantity necessary to properly complete the test. Interruption or delay of CONTRACTOR's Work progress caused by testing and sampling shall not be cause for extra payment under the Contract nor shall they be cause for extension of Contract Time.

E. Water main shall be disinfected according to the Standard Specifications for Water and Sewer Main Construction in Illinois, which shall include initial flush and disinfection to 50 ppm with gaseous chlorine or other acceptable methods. Acceptable concentration after 24 hours shall be 25 ppm. Satisfactory disinfection shall be demonstrated in accordance with the requirements of 35 Ill. Adm. Code 652.203.

F. Broken concrete, rubble fill, and other excess material shall be removed from the site and wasted.

G. All waste disposal areas and all areas used for the storage of materials or the temporary deposit of excavated earth shall be leveled off, cleaned up, and returned to condition that existed prior to construction.

H. All surplus material, tools, and equipment shall be removed, and the premises shall be left free of everything of the kind.

3.4 CLEANUP

A. Upon completion of the work, all improvements disturbed by CONTRACTOR's operations shall be repaired or replaced. Broken concrete, rubble fill, and other excess material shall be removed from the site and wasted.

B. All areas used for the storage of materials or the temporary deposit of excavated earth shall be leveled off and cleaned up. All surplus material, tools, and equipment shall be removed, and the premises shall be left free of everything of the kind.

C. All pipes and manholes shall be flushed until clean, and all debris and mud shall be removed.

3.5 DEMOLITION

A. All exterior piping removals, including manholes and appurtenances and abandonment, shall be by CONTRACTOR. The locations and elevations of existing piping are approximate. Where necessary, existing piping shall be exposed before installing new piping. Any changes in pipe location or elevation shall be reviewed by ENGINEER.

B. CONTRACTOR shall remove or abandon all existing piping and appurtenances as noted. Unless otherwise shown or specified, piping and appurtenances to be removed shall become the property of CONTRACTOR and shall be removed from the site for salvage or disposal. Unless otherwise shown or specified, piping shown or specified to be abandoned shall have each end plugged with concrete or nonshrink grout. Nonshrink grout shall be as specified in Division 03. Wherever excavations cross piping to be abandoned, piping shall be removed to the limits of the excavation and the ends shall be filled as specified above.

C. Valve boxes and exposed valves and operators on piping to be abandoned shall be removed. All concrete surfaces to remain shall be patched as required to provide a smooth surface. Repiping and connections to new piping shall be as specified for new piping.

D. It is the responsibility of CONTRACTOR to remove the items listed below, including piping and appurtenances, as specified, and patch all holes resulting therefrom unless specified or shown otherwise. The intent of these specifications is to require that the removal of materials, patching of all existing holes, and repiping be done in a workmanlike manner. All costs shall be included in the Lump Sum Bid.

END OF SECTION

SECTION 40 05 00
PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Work included:
   1. All piping, valves, and appurtenances of every description except for pipe as specified in Division 33.
   2. Concrete foundations and anchor bolts for all equipment furnished under this section.
   3. Piping connections to all equipment, whether furnished under this section or not.

B. Related Sections and Divisions: Applicable provisions of Division 01 shall govern work in this section.

1.2 SUBMITTALS

A. Applicable provisions of Section 01 33 00–Submittals cover requirements for shop drawings and Operation and Maintenance Manuals.

B. General arrangement drawings, including support system of 3 inches or larger interior and 3 inches or larger exterior (aboveground) ductile iron, PVC, and CPVC piping shall be submitted to ENGINEER for approval. Shop drawings for all interior and aboveground exterior piping shall be two line drawings drawn to scale. Drawings shall include proposed materials, length, location, and elevation of pipe, fittings, supports, and valves and appurtenances. Plug valve orientation, including operator and plug orientation, shall be shown on Drawings.

C. Grooved joint couplings and fittings shall be referred to on arrangement drawings and product submittals, and be identified by the manufacturer’s listed model or series designation.

PART 2 - PRODUCTS

2.1 MATERIALS OF CONSTRUCTION

A. Materials of Construction: All materials used in the manufacture, assembly, and painting of piping and valves in contact with water shall be compatible with potable water supplies and in contact with chemical feed systems shall be compatible with the chemicals being used. All glues, solvents, solders, etc., shall likewise be compatible. For instance, no lead base solders shall be used. Products used in potable water systems shall be UL classified in accordance with ANSI/NSF 61 for potable water service and shall meet the low lead requirements of NSF 372.

B. Size and Type:
   1. All materials shall conform to the size and type shown on the Drawings or called for in the specifications.
   2. In joining two dissimilar types of pipe, standard fittings shall be used when available. In the event standard fittings are not available, the method of joining shall be selected by CONTRACTOR and submitted for review by ENGINEER.

C. Piping appurtenances shall be made of the materials specified. All appurtenances not designated as to type shall be subject to approval of ENGINEER. All grooved joint couplings and fittings shall be of the same manufacturer.

2.2 PIPE AND PIPE FITTINGS

A. Ductile Iron Piping and Fittings:
   1. Unless otherwise shown or specified, all interior piping 4 inches in diameter or larger shall be ductile iron conforming to AWWA C151.
   2. Interior piping shall be minimum Special Class 53 with a minimum rated working pressure of 250 psi.
   3. Except where shown, interior pipe joints shall be flanged. Flanged joints shall conform to applicable flanged joint sections of AWWA C110 and C115 and shall be compatible with ANSI B16.1 Class 125. Flanges shall be cast or ductile iron. Manufacturers of flanged pipe and fittings shall be certified to NSF 61 by an ANSI accredited third party certification organization.
   4. Flanged gaskets shall be minimum 1/8 inch thick rubber "ring" gaskets, not full faced gaskets. Thicker gaskets shall be provided as recommended by the manufacturer to meet joint tolerances.
   5. Flange bolts shall be standard zinc plated steel with hex head and hex nuts for the rated working pressures and installation conditions specified or shown.
   6. Interior fittings shall be flanged and of ductile or cast iron. Flange fittings shall conform to AWWA C110 and ANSI B16.1, as applicable, with a minimum rated working pressure of 150 psi.
   7. Gaps between flanges and all locations where a gap exists at flange hub/pipe intersection shall be caulked prior to finish painting with Sonneborn NP 1 by Sonneborn Chem Rex, Inc., Sika FLEX 1 A, or equal.
   8. Flanged joints shall conform to AWWA C110, C111, and C115, and shall be compatible with ANSI B16.1 Class 125. Flanges shall be ductile iron. Flanged gaskets shall be minimum 1/8 inch, full face, rubber ring, Toruseal, Flange Tyte, Maloney, or equal, gaskets. Thicker gaskets shall be provided as recommended by the manufacturer to meet joint tolerance. Flange bolts shall be standard zinc plated steel with hex head and hex nuts for the rated working pressure and installation conditions specified or shown.
   9. Flanged fittings shall be of ductile iron with ductile iron flanges. Flanged fittings shall conform to AWWA C110 and ANSI B16.1, as applicable, with a minimum rated working pressure of 150 psi.
   10. All ductile iron fittings shall be American, Clow, Griffin, Tyler, U.S. Pipe, or equal.
   11. All flanged sections of pipe shall be made up in accordance with AWWA C115 specifications. No field makeup flanges will be allowed unless strictly conforming to AWWA C115, with facing done after turning pipe through flange.

12. Unless otherwise specified, all ductile iron piping and fittings shall be cement mortar lined and asphaltic coated inside. Cement mortar lining shall be in accordance with AWWA C104. Asphaltic coating shall conform to applicable standards herein for the pipe and fittings. Exterior exposed, submerged, and interior piping shall be furnished with outside surfaces prepared by abrasive blasting in accordance with NAPF 500C 03. Cleaned surfaces shall then be shop primed. Factory shop prime with one coat of Tnemec N69 or N140 or Sherwin Williams Duraplate 235 or Macropoxy 646PW, or equal, applied at a minimum 5.0 mils dry film thickness. Primer color shall be beige. Primer used shall be compatible with proposed finish coats; CONTRACTOR shall verify. It is the intent of this specification that all piping, supports, and appurtenances shall be furnished shop primed, clean, and ready to accept finish painting by CONTRACTOR with a minimal amount of surface preparation. Preparation and painting shall conform to all requirements and provisions specified in Division 09.
13. Unless otherwise specified, piping and fittings in manholes and wet wells shall be as furnished above for exterior exposed and interior piping.

2.3 VALVES

A. Gate Valves:
1. Shutoff valves in potable and non-potable water lines 4-inch diameter and larger shall be AWWA C515, ductile iron, resilient seat, nonrising stem, 150 psi working pressure with O-ring packing box, Kennedy, American, American AVK, or equal.
2. Underground valves shall have extended stem, cast iron telescopic valve box, and key. Exposed valves not in reach of the floor (7 feet to centerline, or greater) shall have chain wheel operator. All other valves shall have handwheels. Right angle operators shall be provided, if required, because of valve position.
3. Asphaltic varnish and coal tar coating are not allowed on interior valves. Exterior buried valves shall be fusion bonded epoxy coated or epoxy coated (prime and finish coats) as specified in Division 09. Interior and exterior exposed valves shall be furnished with all surfaces (except galvanized or stainless steel) prepared in accordance with near white grade SSPC Specification No. 10 removing all dirt, rust scale, and foreign materials. Surface preparation shall be done at such time during the assembly process as to preclude damage to the valve once assembled. Cleaned surfaces shall then be shop primed. Factory shop prime with one coat of Tnemec N69 or N140 or Sherwin Williams Duraplate 235 or Macropoxy 646PW, or equal, applied at a minimum 5.0 mils dry film thickness. Primer color shall be beige. Primer used shall be compatible with proposed finish coats; CONTRACTOR shall verify. A fusion bonded epoxy system is an acceptable alternative to the specified primer. It is the intent of this specification that all valves, supports, and appurtenances shall be furnished shop primed, clean, and ready to accept finish painting by CONTRACTOR with a minimal amount of surface preparation. Preparation and painting shall conform to all requirements and provisions specified in Division 09.

B. Check Valves:
   1. Except where noted, check valves in ductile iron lines carrying liquid shall be GA Industries Figure 230 DS, Apco Model 250 LS by DeZURIK, (outside lever and spring), GA Industries Figure 220 DS, Apco Model 250 LW by DeZURIK, (lever and weight), or equal, 150 psi, ductile iron or iron body, bronze or stainless trimmed, swing check. Two levers and springs, heavier springs and/or additional weights shall be used if necessary to stop slamming.
   2. Valve Boxes:
      a. Valve boxes shall be provided for all buried valves.
      b. Valve boxes shall be made of cast iron conforming to ASTM A48, Class 20. Valve boxes shall consist of a base section, tubular mid and top sections, both with cast threads by which one can be telescoped on the other, extension sections if required, and a circular drop cover. The castings shall be free from blowholes, porosity, hard spots, shrinkage defects or cracks, or other injurious defects and shall have a normal smooth casting finish. The castings shall be thoroughly coated with a 1 mil minimum thickness bituminous coating. Valve boxes shall be 5 1/4 inches in diameter. Valve boxes shall have a maximum length of 7 feet when extended without extension sections. Extensions shall be provided for deeper mains.
      c. The valve box shall be centered and plumb over the wrench nut of the valve with the box cover flush with the finished ground elevation. Solid 4-inch concrete blocks shall be placed under the base of valve boxes so that the bottom of the base is about 2 inches away from contact with the valve bonnet. The valve box shall not transmit shock or stress to the valve.
      d. Valve box alignment devices: All valves shall be supplied with a gate valve adaptor as manufactured by Adaptor, Inc., or equal. All adaptors shall have a metal frame and be supplied with a 3/4-inch rubber gasket. All adaptors shall be sized to fit the brand of valve being supplied.

2.4 PIPING APPURTENANCES AND MISCELLANEOUS MATERIALS

A. General: Piping appurtenances shall be made of the materials specified. All appurtenances not designated as to type shall be subject to approval of ENGINEER.

B. Non Potable Water Caution Signs: Place non potable water signs permanently mounted at every hose bib, hydrant, or faucet on the non potable water system. Sign shall include as a minimum the wording “CAUTION, NON POTABLE WATER, DO NOT DRINK” or similar standard language. Signs shall be Brady Safety sign, or equal, minimum size 7 inches by 10 inches, constructed of fiberglass. Mount signs on building wall or structures with stainless steel screws or fasteners. At yard hydrant, provide post mounted signs on steel U channel posts.

C. Rubber Expansion Joints: Rubber expansion joints shall be furnished and installed where shown on the Drawings and where required to eliminate vibration from equipment to piping. Expansion joints shall be the single filled arch type as manufactured by the Mercer Rubber Company, Series Style 451 or 500; General Rubber Corporation; or equal. Unless otherwise specified, expansion joints shall be

provided complete with control rods and rubber washers as required. Control rods shall be provided to prevent over stress on coupling at a minimum of twice the system test pressure. The number and size of the control rods shall be sufficient for twice the test pressure, two rods minimum. Expansion joints shall have integral duck and rubber flange with split backup rings and have a minimum rated working pressure of 150 psi. Joints shall be provided with higher rated working pressures, if required to meet specified test pressures. Joints shall have a nominal laying length of 6 inches for joints sized up to 8 inches in diameter, 8 inches for joints sized up to 20 inches in diameter, and 10 inches for joints sized up to 36 inches in diameter. Tube and cover shall be of butyl rubber.

D. Pipe Coupling: Pipe couplings identified on the Drawings shall be Dresser Type 38, Smith Blair 411, or equal, steel coupling. CONTRACTOR shall provide tie ears and tension ties where necessary to restrain pipe.

E. Tension Ties: All tension ties, rod ties, and control rods shall be provided to resist a minimum 150 psi 250 psi pressure in the pipe line. CONTRACTOR shall provide tie ears to secure tension rods to flanges where necessary. Rods shall be provided with nuts and washers on both sides of tie ears. All nuts shall be carbon alloy steel conforming to ASTM A563, and washers shall be hardened steel conforming to ASTM F436. Rods shall be ASTM A36 steel at a minimum. Tie rods shall be equally spaced around pipe. The following table lists the minimum number and diameter in inches for the tie rods for various sizes of pipe.

	150 psi Pressure		250 psi Pressure	
Pipe Size (inches)	Minimum Number	Minimum Size (inch-es)	Minimum Number	Minimum Size (inch-es)
4-10	4	5/8	4	5/8
12	4	5/8	4	3/4
14	4	3/4	4	7/8
16	4	3/4	4	1
18	4	7/8	4	1 1/8
20	4	1	4	1 1/4
24	4	1 1/8	4	1 1/2
30	4	1 3/8	7	1 3/8
36	8	1 1/4	8	1 1/2
42	12	1 1/8	12	1 1/2
48	11	1 3/8	22	1 1/4
54	11	1 1/2	22	1 3/8

F. Service Saddle: Service saddles shall have a ductile iron body per ASTM A536 and have two carbon steel bales. Bales, washers and nuts shall be electro galvanized with dichromate seal. Gasket shall be of Nitrile rubber and NSF61 listed. Saddle shall be Smith Blair, Style 313, or equal.

G. Tapping Sleeve: Tapping sleeve body and neck shall be made of heavy 18 8 Type 304 stainless steel. Flange, studs, nuts and washers shall be 304 stainless steel. Gasket shall be 1/4 inch thick, gridded and have a molded outlet ring to provide effective sealing. It shall be SSF 61 G Nitrile. All welded stainless steel surfaces shall be fully passivated. Sleeve shall be Smith Blair Style 663, or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to requirements specified in Division 01 for equipment installation, quality control, testing, supervision, start-up, and operator training.

3.2 INSTALLATION

A. Interior or Exposed Piping:
1. Provide pipe supports for all piping. Pipe support spacing and type shall, at a minimum, conform to manufacturer's recommendations unless more restrictive requirements are specified.
2. All piping shall be adequately supported and braced to resist thrust at bends and joints. Use base elbows, poured concrete, or rod ties. The weight of the piping shall be supported independently of connected equipment.
3. All supports and parts shall conform to the latest requirements of ASME B31 and shall have a structural safety factor of 5. Accurate weight balance calculation shall be made by CONTRACTOR to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection. CONTRACTOR shall be responsible for the installation and application of the supports. Pipe hangers shall be capable of supporting the pipe weight load in all conditions of operation. The hangers shall allow free expansion and contraction of the piping to prevent excessive stress in the piping. Where vertical movement up to 1/8 inch is anticipated, a precompressed variable spring support shall be used. Rigid hangers shall be provided with a means of vertical adjustment after erection. Where horizontal piping movements are greater than 1/2 inch, or where the hanger rod angularity from vertical is greater than 4 degrees from hot to cold position of the pipe, the hanger pipe and structural attachments shall be offset in a manner that the rod is vertical in the hot position. Hangers and supports shall be spaced in accordance with ASME B31 and as indicated in this specification. Pipe supports shall be placed before and after a valve, expansion joint, or equipment so stress will not be transferred to them.
4. CONTRACTOR shall provide calculations of pipe supports if requested by ENGINEER.
5. All carbon steel parts shall be furnished with all surfaces (except galvanized or stainless steel) prepared in accordance with near white grade SSPC Specification No. 10 removing all dirt, rust scale, and foreign materials. Surface preparation of all carbon steel parts shall be performed at such time during the assembly process as to preclude damage to the equipment once installed and assembled. Cleaned surfaces shall then be shop primed. Factory shop prime with one coat of Tnemec N69 or N140 or Sherwin Williams

Duraplate 235 or Macropoxy 646PW, or equal, applied at a minimum 5.0 mils dry film thickness. Primer color shall be beige. Primer used shall be compatible with proposed finish coats; CONTRACTOR shall verify. It is the intent of this specification that all equipment, supports, and appurtenances shall be furnished shop primed, clean, and ready to accept finish painting by CONTRACTOR with a minimal amount of surface preparation. Preparation and painting shall conform to all requirements and provisions specified in Division 09.

6. The following maximum spacings shall be provided for supports:

MAXIMUM HORIZONTAL PIPE HANGER AND SUPPORT SPACING

	Copper Tubing			
Nominal Pipe or Tube Size	Water Service ft	Vapor or Air Service ft	Ductile Iron (See Note 1) ft	PVC/CPVC Pipe (See Note 2) ft
1/4	5	5		
3/8	5	6		Continuous
1/2	5	6		Continuous
3/4	5	7		Continuous
1	6	8		4
1 1/4	7	9		4
1 1/2	8	10		4
2	8	10		4
2 1/2	9	10		4
3	10	10		4
4	10	10	10	4
5	10	10	10	4
6	10	10	10	9
8	10	10	10	9
10	10	10	10	10
12	10	10	10	10
14			10	10
16			10	10
18			10	10
20			10	
24			10	
30			10	
36			10	
42			10	

Note 1: Provide at least one hanger per pipe length located as close to the flange or joint on barrel as possible.

Note 2: Spacing is based on Schedule 80 at 100°F. For Schedule 40 or higher temperatures, provide shorter span. Consult local plumbing code and manufacturer's recommendations as required. Minimum spacing requirements shall govern.

7. The length of hanger span and support spacing in the above table refers to straight lengths of pipe. When there are changes of direction in pipe, two supports shall be placed less than three fourths the full span in the table. When practical, a hanger shall be located immediately adjacent to a change in direction of piping. Where there are concentrated loads between supports such as valves, spacing shall be based on load calculations rather than this table.
8. Except for flanged piping, an ample number of standard weight ground joint unions and a shutoff valve shall be provided in all pipelines and at all equipment. CONTRACTOR shall provide 3/8 inch tapped and plugged connections in suction and discharge of all pumps for testing.
9. Valves shall be located on all branches of water supply lines where shown on the drawings. Position valves to facilitate access and operation.
10. The locations and elevations of existing piping are approximate. Any changes in the pipe location or elevation shall be reviewed by ENGINEER.
11. CONTRACTOR shall submit shop drawings showing new pipe routing and existing pipe removal. CONTRACTOR shall be responsible for final pipe routing and shall route new piping as required to minimize conflicts. Piping shown on the Drawings is approximate only. Not all existing piping, conduit, equipment, etc., are shown on the Drawings. CONTRACTOR shall field verify locations. CONTRACTOR shall reroute existing piping, conduit, etc., as indicated or as required to install new piping or equipment. CONTRACTOR shall remove and relocate existing pipe supports as required to install new piping. CONTRACTOR shall provide all piping, fittings, flange fillers, and other appurtenances as required to provide functional system at no additional cost to OWNER.

3.3 FIELD QUALITY CONTROL

A. CONTRACTOR shall include the cost of all testing, cleaning, and disinfection in the price Bid.

B. Work shall be tested as specified in this section. Unless indicated by ENGINEER in writing before testing begins, tests shall be witnessed by ENGINEER and others as necessary. Test results shall be recorded, and reports or appropriate certificates shall be submitted to ENGINEER in triplicate.

C. New piping shall be tested. Piping, interior or exposed, shall be subject to test before being covered with insulation or paint. Piping and appurtenances shall be watertight or airtight and free from visible leaks.

D. Piping shall be flushed or blown out after installation and prior to testing. CONTRACTOR shall provide all necessary piping connections, water, air, test pumping equipment, water meter, bulkheads, valves, pressure gauge and other equipment, materials, and facilities necessary to complete the specified tests. CONTRACTOR shall provide all temporary sectionalizing devices and vents for testing.

E. Gauges used for testing shall have increments as follows:
   1. Tests requiring a pressure of 10 psi or less shall use a testing gauge having increments of 0.10 psi or less.

2. Tests requiring a pressure of greater than 10 psi but less than or equal to 100 psi shall use a testing gauge having increments of 1 psi or less.
3. Tests requiring a pressure of greater than 100 psi shall use a testing gauge having increments of 2 psi or less.

F. Pressure Tests: The test pressure in all lines shall be held for one hour during which time the leakage allowance shall not exceed that specified. In case repairs are required, the pressure test shall be repeated until the pipeline installation conforms to the specified requirements. Pumps, air compressors, instrumentation, and similar equipment shall not be subjected to the pressure tests. All piping conveying a combination of fluids, such as SCM/WAS, shall be tested at the higher test pressure.

Fluid Abbreviation or Name	Minimum Test Pressure in psi	Test Medium	Leakage Allowance Designation
Non-potable water	150	Water	"A"

[1] Leakage allowance Designation "A" shall mean zero leakage.

3.4 CLEANING AND DISINFECTION

A. All equipment and materials shall be clean before installation. CONTRACTOR shall disinfect and flush the system before it is put on line.

B. CONTRACTOR shall obtain water samples and arrange for analysis of water in potable systems for bacteria as part of the Lump Sum Bid. Copies of test results shall be submitted to OWNER and ENGINEER.

C. Broken concrete, rubble fill, and other excess material shall be removed from the site and wasted.

D. All surplus material, tools, and equipment shall be removed and the premises shall be left free of everything of the kind.

END OF SECTION