PROJECT MANUAL
VOLUME 2 OF 2

PFLUGERVILLE RENOVATION PROJECTS – FINE ARTS

PFLUGERVILLE INDEPENDENT SCHOOL DISTRICT

PFLUGERVILLE, TEXAS

August 4, 2020
ISSUED FOR BIDDING & CONSTRUCTION

Project No.19-084

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![Hollon + Cannon Group, Inc.]

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Registered Architect

Robert L. Harris

08-04-2020
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 CHECKING DOCUMENTS:

A. The drawings and specifications are numbered consecutively. The Contractor shall check the drawings and specifications thoroughly and shall notify the Architect of any discrepancies or omissions of sheets or pages. Upon notification, the Architect will promptly provide the Contractor with any missing portions of the drawings or specifications. No discrepancies or omissions of sheets or pages of the contract documents will relieve the Contractor of his duty to provide all work required by the complete contract documents.

1.3 SUMMARY

A. This Section includes the following:
   1. General Provisions for Construction
   2. Piping materials and installation instructions common to most piping systems.
   3. Mechanical sleeve seals.
   4. Sleeves.
   5. Escutcheons.
   7. Fire-suppression equipment and piping demolition.
   8. Equipment installation requirements common to equipment sections.
   10. Concrete bases.
   11. Supports and anchorages.
   12. Close-out Documents and Requirements

1.4 TERMINOLOGY

A. Whenever the words "furnish", "provide", "furnish and install," "provide and install", and/or similar phrases occur, it is the intent that the materials and equipment described be furnished, installed and connected under this Division of the Specifications, complete for operation unless specifically noted to the contrary.

B. Where a material is described in detail, listed by catalogue number or otherwise called for, it shall be the Contractor's responsibility to furnish and install the material.

C. The use of the word "shall" conveys a mandatory condition to the contract.

D. "This section" always refers to the section in which the statement occurs.

E. "The project" includes all work in progress during the construction period.
F. In describing the various items of equipment, in general, each item will be described singularly, even though there may be a multiplicity of identical or similar items.

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

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

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

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

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

L. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.5 GENERAL:

A. In general, the lines to be installed under these specifications shall be run as indicated, as specified herein, as required by particular conditions at the site, and as required to conform to the generally accepted standards as to complete the work in a neat and satisfactorily workable manner. The following is a general outline concerning the running of various lines and ducts and is to be excepted where the drawings or conditions at the building necessitate deviating from these standards.

B. All piping shall be concealed in chases in finished areas, except as indicated on the drawings. Horizontal lines run in areas that have ceilings shall be run concealed in those ceilings, unless otherwise specifically indicated or directed.

C. Piping may be run exposed in machinery and equipment spaces, where serving as connections to equipment items in finished rooms where exposed connections are required, and elsewhere as indicated on the drawings or required.

D. The Contractor shall thoroughly acquaint himself with the details of the construction and finishes before submitting his bid as no allowances will be made because of the Contractor's unfamiliarity with these details. Place all inserts in masonry walls while they are under construction. All concealed lines shall be installed as required by the pace of the general construction to precede that general construction.

E. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to provide proper grading of lines, to avoid all obstruction, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated, satisfactorily operating installation.

F. The mechanical and electrical plans do not give exact locations of outlets, fixtures, equipment items, etc. The exact location of each item shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and
in cooperation with other sections. Minor relocations necessitated by the conditions at the site or as directed by the Architect shall be made without any additional cost accruing to the Owner.

G. The Contractor shall be responsible for the proper fitting of his material and apparatus into the space. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the drawings, he shall arrange for such space with the Architect before submitting his bid. Should changes become necessary on account of failure to comply with this clause, the Contractor shall make such necessary changes at his (the Contractor’s) own expense.

H. Order of precedence shall be observed in laying out the pipe, ductwork, material, and conduit in order to fit the material into the space above the ceiling and in the chases and walls. The following order shall govern:
1. Items affecting the visual appearance of the inside of the building such as lighting fixtures, diffusers, grilles, outlets, panelboards, etc. Coordinate all items to avoid conflicts at the site.
2. Lines requiring grade to function such as sewers.
3. Large ducts and pipes with critical clearances.
4. Conduit, water lines, and other lines whose routing is not critical and whose function would not be impaired by bends and offsets.

I. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention before the contract is signed. Otherwise, the Contractor shall be responsible for any and all changes and additions that may be necessary to accommodate his particular apparatus, material, or equipment.

J. The Contractor shall distinctly understand that the work described herein and shown on the accompanying drawings shall result in a finished and working job, and any item required to accomplish this intent shall be included whether specifically mentioned or not.

K. Each bidder shall examine the plans and specifications for the General Construction. If these documents show any item requiring work under Division 21 and that work is not indicated on the respective fire protection or plumbing drawings, he shall notify the Architect in sufficient time to clarify before bidding. If no notification is received, the Contractor is assumed to require no clarification, and shall install the work as indicated on the General Plans in accordance with the specifications.

1.6 DIMENSIONS:

A. Before ordering any material or doing any work, the Contractor shall verify all dimensions, including elevations, and shall be responsible for the correctness of the same. No extra charge or compensation will be allowed on account of differences between actual dimensions and measurements indicated on the drawings. Any difference which may be found shall be submitted to the Architect for consideration before proceeding with the work.

1.7 INSPECTION OF SITE:

A. The accompanying plans do not indicate completely the existing installations. The bidders for the work under these sections of the specifications shall inspect the existing installations and thoroughly acquaint themselves with conditions to be met and the work to be accomplished in removing and modifying the existing work, and in installing the new work in the present building and underground serving to and from that structure. Failure to comply with this shall not constitute grounds for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work.
1.8 SUBMITTALS

A. Wherever shop drawings are called for in these specifications, they shall be furnished by the Contractor for the work involved after review by the Architect as to the make and type of material and in sufficient time so that no delay or changes will be caused. This is done in order to facilitate progress on the job and failure on the part of the Contractor to comply shall render him liable to stand the expense of any and all delays, changes in construction, etc., occasioned by his failure to provide the necessary details. Also, if the Contractor fails to comply with this provision, the Architect reserves the right to go directly to the manufacturer he selects and secure any details he might deem necessary and should there be any charges in connection with this, they shall be borne by the Contractor.

B. Shop drawings will be reviewed by the Architect for general compliance with the design concept of the project and general compliance with the information given in the contract documents. Review by the Architect and any action by the Architect in marking shop drawings is subject to the requirements of the entire contract documents. Contractor will be held responsible for quantities, dimensions which shall be confirmed and correlated at the job site, fabrication processes and techniques of construction, coordination of all trades and the satisfactory performance of his work.

C. Shop drawings submitted shall not consist of manufacturers' catalogues or tear sheets therefrom that contain no indication of the exact item offered. Rather, the submission of individual items shall designate the exact item offered and shall clearly identify the item with the project.

D. All shop drawings shall be submitted at one time and shall consist of a bound catalogue of all shop drawings under each section, properly indexed and certified that they have been checked by the Contractor.

E. The omissions of any material from the shop drawings which has been shown on the contract drawings or specified, even though reviewed by the Architect, shall not relieve the Contractor from furnishing and erecting same.

F. Product Data: For the following:
   1. Mechanical sleeve seals.
   2. Escutcheons.
   3. Material indicated in other Division 21 Sections.

G. Welding certificates.

1.9 QUALITY ASSURANCE

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

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
1.10 LAWS, CODES AND ORDINANCES:

A. All work shall be executed in strict accordance with all local, state and national codes, ordinances and regulations governing the particular class of work involved, as interpreted by the inspecting authority. The Contractor shall be responsible for the final execution of the work under this heading to suit those requirements. Where these specifications and the accompanying drawings conflict with these requirements, the Contractor shall report the matter to the Architect, shall prepare any supplemental drawings required illustrating how the work may be installed so as to comply and, on approval, make the changes at no cost to the Owner. On completion of the various portions of the work the installation shall be tested by the constituted authorities, approved and, on completion of the work, the Contractor shall obtain and deliver to the Owner a final certificate of acceptance.

1.11 DELIVERY, STORAGE, AND HANDLING

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

B. Refer to other Division 21 Sections for additional requirements.

1.12 GUARANTEE:

A. Unless a longer guarantee is hereinafter called for, all work, material and equipment items shall be guaranteed for a period of one year after acceptance by the Owner. All defects in labor and materials occurring during this period, as determined by the Architect, shall be repaired and/or replaced to the complete satisfaction of the Architect. Guarantee shall be in writing and in triplicate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
   a. Where a definite material is mentioned in these specifications, it has been done in order to establish a standard. The product of the particular manufacturer mentioned is of satisfactory construction and any substitution must be of quality as good as or better than the named article. No substitution shall be made without review by the Architect, who will be the sole judge of equality.
   b. Should a substitution be accepted under the provisions of the conditions of these specifications, and should this substitute prove to be defective or otherwise unsatisfactory for the service for which it is intended within the guarantee period, the Contractor who originally requested the substitution shall replace the substitute material with the specified material.

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Available Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Plastic. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

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

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

E. Split sleeves will not be acceptable.

2.6 ESCUTCHEONS

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

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 FIRE-SUPPRESSION DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. Salvage Materials:
1. The Contractor shall remove existing equipment, piping, and other items associated with the fire suppression systems that are not to be reused and where shown on the drawings. When the work is complete, there shall be no "dead" lines left installed in any portion of the area being remodeled, which shall include any temporary connections.

2. Where such items are exposed to view or uncovered by any cutting or removal of general construction and has no continuing function (as determined by the Architect), they shall be removed by the contractor under the section in which the item normally falls.

3. Existing items (see above) where concealed in/above construction which is not disturbed, abandon in place. Plug, cap, disconnect or otherwise render harmless all such items.

4. All items or materials removed from the project shall be made available for the Owner's inspection. The Owner retains the option to claim any item or material. Contractor shall deliver any claimed item or material in good condition to the place designated by the Owner. All items not claimed become the property of the contractor and shall be removed from the site.

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

3.2 BORED CROSSINGS:

A. Crossings beneath sidewalks may be bored rather than open-cut but casing is not required. The trench may be open cut to within three feet of the edge of the pavement. Boring shall proceed from a pit provided for the boring equipment and workmen. The use of water or other fluids in connection with the boring operation will be permitted only to the extent required to lubricate cuttings. Jetting will not be permitted. Care shall be taken to keep the bore on proper line and grade.

3.3 OPENING AND RECLOSING PAVEMENT:

A. Where excavation requires the opening of existing walks, streets, drives or other existing pavement, that pavement shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be completed and when the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them. Quality of the patch shall be equal to or better than adjacent paving.

3.4 RELOCATION OF EXISTING INSTALLATIONS:

A. There are portions of the existing fire suppression system which shall remain in use to serve the finished building in conjunction with the indicated new installations. By actual examination at the site, each bidder shall determine those portions of the remaining present installations which must be relocated to avoid interferences with the installations of new work of his particular trade and that of all other trades. All such existing installations which interfere with new installations shall be relocated by the Contractor under the Division in which the existing material normally belongs, and in a manner as directed by the Architect.

B. Failure to become familiar with the extent of the relocation work involved shall not relieve the Contractor of responsibility and shall not be used as a basis for additional compensation.

3.5 ACCESS PANELS:

A. Wherever valves or other components are installed and access is required through either walls or ceilings and such cannot be obtained through the removable ceiling or through other means, the Contractor shall provide Milcor Style "M" access doors at least 12 inches by 12 inches in size or larger if required for access. Provide rated access panels as required for installation in rated construction.
3.6 USE OF SYSTEM:

A. In general, the fire suppression systems shall be installed in a timely manner, at a pace consistent with the general construction, but shall then be made operational as soon as practicable to provide protection during the remainder of construction. Where underground service lines and hydrants are included in the project, they shall be installed, completed, and placed in service prior to construction work. Water service lines shall be extended to the building and made available prior to the delivery of any combustible building materials.

B. The use of the equipment and system for providing building fire protection shall in no way constitute acceptance of that equipment and the connected piping by the Owner. Furthermore, it shall in no way shorten the guarantee period hereinafter specified. The Contractor shall either secure extended warranties from the vendors of equipment or shall purchase insurance to provide proper coverage on the equipment through the guarantee period and shall file with the Architect substantiating affidavits from equipment manufacturers or a copy of the insurance policy covering the equipment through the guarantee period. The personal underwriting of the Contractor for equipment manufacturers' warranties is not acceptable, but his personal underwriting of piping, ductwork, insulation and associated materials is acceptable subject to the provisions of the contract.

3.7 OWNERS OCCUPANCY:

A. It shall be understood that the building in which the work is to be done is a necessary part of the Owner's operation, and shall continue in use throughout the construction period without interruption. Take all precautions required by the Owner for the protection of his equipment and property.

B. Contractor shall cooperate with the owner in scheduling areas in which work is permitted. Owners schedule will govern.

3.8 SCHEDULE OF WORK:

A. The Contractor shall program his work in such manner as to interfere as little as possible with the normal routine of the Owner. It must be understood that the Owner will continue to function throughout the construction period. All water and sanitary facilities shall therefore be continued in operation with a minimum of interruption and the Contractor shall make any temporary connections necessary to comply with this requirement.

B. The work under the various sections must be expedited and close coordination will be required in executing the work. The various trades shall perform their portion of the work at such times as directed so as to insure meeting scheduled completion dates, and to avoid delaying any other trade. The Architect will set up completion dates, schedule the times of work in the various areas involved, etc. Each Contractor shall cooperate in establishing these times and locations and shall process his work so as to insure the proper execution of it.

C. Under no condition shall any work be done in the present building that would interfere with its natural use during its normal hours of occupancy, unless special permission is granted by the Owner. This is particularly applicable where new connections are to be made to present lines or items of equipment in that building or where present equipment items in that building are to be relocated or modified in any way. The Contractor shall include this scheduling requirement in his proposal as no additional compensation for overtime work will be granted.

3.9 WORKING TIME:

A. Where new connections are to be made into existing lines, present lines must be relocated or rerouted, present equipment items relocated or other work accomplished that would affect the operation of the
present building, the work shall be carried on at such times as to cause a minimum of interference with
the normal operation of that building. In certain cases the work may be accomplished during normal
working hours during certain designated seasons or times of the year. In other cases the work may
have to be executed during times of the day outside of the normal working period, on holidays, etc.
Each individual case presents a separate decision as to the time during which it shall be performed.
The Contractor involved shall present each case to the Architect for his decision, which will be made
after due consultation with the Owner. No additional compensation for overtime will be granted for
compliance with these requirements.

3.10 PIPING SYSTEMS - COMMON REQUIREMENTS

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

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

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Fire sprinkler piping shall not be supported with hangers of other trades, and in no way shall be used to
   support the work of other trades. Hangers for fire sprinkler piping shall be independent of all other
   supports.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass
         type with polished chrome-plated finish.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: **One-piece or split-casting**, cast-
         brass type with polished chrome-plated finish.
      e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with **rough-brass
         finish**.
      f. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
2. Existing Piping: Use the following:
   a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
   d. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with rough-brass finish.
   e. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section “Sheet Metal Flashing and Trim” for flashing.
         1) Seal space outside of sleeve fittings with grout.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section “Joint Sealants” for materials and installation.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

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

3.11 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.12 ELECTRICAL WIRING:

A. All electric wiring of every character, shall be done under Divisions 26 and 27 of these specifications. The Contractor for each section shall erect all his motors in place ready for connections. The Contractor, under Division 26, shall mount all the starters and controls, furnishing the supporting structures and any required outlet boxes.

B. Every electrical current consuming device furnished as a part of this project, or furnished by the Owner and installed in this project, shall be completely wired up under Divisions 26 and 27. Verification of exact location, method of connection, number and size of wires required, voltage requirements, and phase requirements is the responsibility of the Contractor under Divisions 26 and 27. If conflicts occur between the drawings and the actual requirements, actual requirements shall govern.
3.13 SEALING AROUND PIPES

A. The Contractor installing pipes shall seal all spaces between pipes and/or sleeves where they pierce walls, partitions or floors with Johns-Manville Firetemp CI intumescent caulk or as directed by architect. The packing shall effect a complete fire and/or air seal where pipes, ducts, etc., pierce walls, floors or partitions.

3.14 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

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

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

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

3.15 PROGRESS OF WORK:

A. The Contractor shall keep himself fully informed as to the progress of the work and do his work at the proper time without waiting for notification from the Architect or Owner.

3.16 COORDINATION

A. The Contractor shall be responsible for resolving all coordination required between trades. For example, items furnished under Division 21 which require electrical connections shall be coordinated with Divisions 26 or 27 for:
   1. Voltage
   2. Phase
   3. Ampacity
   4. No. and size of wires
   5. Wiring diagrams
   6. Starter size, details and location
   7. Control devices and details

B. Items installed in/on finished ceilings shall be coordinated with the ceiling construction. The Contractor under each section shall conform to the reflected ceiling plan and shall secure details and/or samples of the ceiling materials as necessary to insure compatibility. Any device not conforming to this requirement shall be replaced by the Contractor at his expense.

C. All items specified under Division 21 shall be installed tight, plumb, level, square and symmetrically placed in relation to the work of other trades.

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

E. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
F. Fire sprinkler piping shall not be supported with hangers of other trades, and in no way shall be used to support the work of other trades. Hangers for fire sprinkler piping shall be independent of all other supports.

G. System components shall not be installed in a manner or in locations that would interfere with proper access to components of other systems installed by other trades.

3.17 MANUFACTURER'S DIRECTIONS:
A. All manufactured articles shall be applied, installed and handled as recommended by the manufacturer.

3.18 MATERIALS AND WORKMANSHIP:
A. All materials shall be new unless otherwise specified and of the quality specified. Materials shall be free from defects. All materials of a type for which the Underwriters Laboratories, Inc. have established a standard shall be listed by the Underwriters Laboratories, Inc. and shall bear their label.

B. Wherever the make of material or apparatus required is not definitely specified, the Contractor shall submit a sample to the Architect before proceeding.

C. The Architect reserves the right to call for samples of any item of material offered in substitution, together with a sample of the specified material, when, in the Architect's opinion, the quality of the material and/or the appearance is involved and it is deemed that an evaluation of the two materials may be better made by visual inspection. This shall be limited to plumbing brass, grilles, registers, ceiling outlets and similar items and shall not be applicable to major manufacturers' items of equipment.

D. The Contractor shall be responsible for transportation of his materials to and on the job, and shall be responsible for the storage and protection of these materials and work until the final acceptance of the job.

E. The Contractor shall furnish all necessary scaffolding, tackle, tools and appurtenances of all kinds, and all labor required for the safe and expeditious execution of his contract.

F. The workmanship shall in all respects be of the highest grade and all construction shall be done according to the best practice of the trade.

3.19 COOPERATION AND CLEANING UP:
A. The contractor for the work under each section of these specifications shall coordinate his work with the work described in all other sections of the specifications to the end that, as a whole, the job shall be a finished one of its kind, and shall carry on his work in such a manner that none of the work under any section of these specifications shall be handicapped, hindered or delayed at any time.

B. At all times during the progress of the work, the Contractor shall keep the premises clean and free of unnecessary materials and debris. The Contractor shall, on direction at any time from the Architect, clear any designated areas or area of materials and debris. On completion of any portion of the work, the Contractor shall remove from the premises all tools and machinery and all debris occasioned by the work, leaving the premises free of all obstructions and hindrances.

3.20 TESTING:
A. The Contractor under each division shall at his own expense perform the various tests as specified and required by the Architect and as required by the State and local authorities. The Contractor shall furnish
all fuel and materials necessary for making tests. Notify the Architect a minimum of 24 hours in advance of all tests.

3.21 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

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

3.22 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer’s written instructions.

   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.23 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

C. Field Welding: Comply with AWS D1.1.

3.24 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.25 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

H. Cure placed grout.

3.26 INSTALLATION DRAWINGS:

A. It shall be incumbent upon the Contractor to prepare special drawings as called for elsewhere herein or as directed by the Architect to coordinate the work under each section, to illustrate changes in his work, to facilitate its concealment in finished spaces to avoid obstructions or to illustrate the adaptability of any item of equipment which he proposes to use.

B. These drawings shall be used in the field for the actual installation of the work. Unless otherwise directed, they shall not be submitted for approval but three copies shall be provided to the Architect for his information.

3.27 OPERATING INSTRUCTIONS:

A. The Contractor for each section of the work hereunder shall, in cooperation with the representatives of the manufacturers of the various equipment items, carefully instruct the Owner's representatives in the proper operation of each item of equipment and of each system. During the balancing and adjusting of systems, the Owner's representative shall be made familiar with all procedures.

B. The contractor shall coordinate the date and time for the training with the Owner's representative and shall document attendance with a sign-in sheet. At a minimum, the sign-in sheet shall indicate the date and location of the session, name and organization of each participant, and a list of any material that may be provided. This information shall be provided to the Architect as part of the closeout documents. Failure to provide documentation of training may require the contractor to provide a subsequent training session.

3.28 OPERATING MANUALS:

A. Prepare and submit 3 copies of the operating manuals bound in hard covers. Three weeks prior to completion of the work, the Architect will check the manuals and any additional material necessary to complete the manuals shall be furnished and inserted by the Contractor.

B. Manuals shall contain the following data:
   1. Catalogue data of all equipment.
   2. Shop drawings of all equipment.
   3. Temperature control drawings (reduced in size)
   4. Start-up instructions for major equipment.
   5. Trouble shooting procedures for major equipment.
   6. Wiring diagrams.
   7. Recommended maintenance schedule for equipment.
   8. Parts list for all items.
9. Name and address of each vendor.

3.29 GUARANTEE:

A. Unless a longer guarantee is hereinafter called for, all work, material and equipment items shall be guaranteed for a period of one year after acceptance by the Owner as established by the date of substantial completion. All defects in labor and materials occurring during this period, as determined by the Architect, shall be repaired and/or replaced to the complete satisfaction of the Architect. Guarantee shall be in writing and in triplicate.

B. If a manufacturer’s standard warranty will expire prior to the date indicated above, this contractor shall provide, at no additional cost to the Owner, a factory extended warranty as required for the additional time frame. Documentation of the required extension shall be included in the submittal.

3.30 COMPLETION REQUIREMENTS:

A. Before acceptance and final payment the Contractor under each Division of the specifications shall furnish:
   1. Accurate record drawings, shown in red ink on blue line prints furnished for that purpose all changes from the original plans made during installation of the work. Drawings shall be filed with the Architect when the work is completed.
   2. All manufacturers’ guarantees.
   3. All operating manuals.

3.31 CONTRACTOR’S RESPONSIBILITY FOR FINAL INSPECTION:

1. Before calling for the final inspection, the Contractor under each Division shall carefully inspect his work to be sure it is complete and according to plans and specifications.

END OF SECTION 21 05 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipes, fittings, and specialties.
   2. Fire-protection valves.
   3. Fire-department connections.
   4. Sprinklers.
   5. Alarm devices.
   6. Pressure gages.

1.3 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device.

1.4 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Sprinkler system design shall be approved by authorities having jurisdiction.

   1. The design and installation of the automatic sprinkler systems and the alarm and supervisory systems shall be in strict accordance with all mandatory and recommended provisions of the NFPA, Industrial Risk Insurance (IRI), UL publications, and applicable building code. All recommended provisions of the NFPA (National Fire Codes) listed below shall be considered as mandatory requirements.

   2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

   3. Sprinkler Occupancy Hazard Classifications:
      a. Building Service Areas: Ordinary Hazard, Group 1.
      b. Churches: Light Hazard.
      c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
      d. General Storage Areas: Ordinary Hazard, Group 1.
      e. Laundries: Ordinary Hazard, Group 1.
      f. Libraries except Stack Areas: Light Hazard.
      g. Library Stack Areas: Ordinary Hazard, Group 2.
      i. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
      j. Office and Public Areas: Light Hazard.
      k. Residential Living Areas: Light Hazard.
      l. Restaurant Service Areas: Ordinary Hazard, Group 1.

   4. Minimum Density for Automatic-Sprinkler Piping Design:
a. Residential (Dwelling) Occupancy: 0.05 gpm over 400-sq. ft. area.
b. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
c. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft area.
d. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.

5. Maximum Protection Area per Sprinkler:
   a. Residential Areas: 400 sq. ft..
   b. Office Spaces: 120 sq. ft..
   c. Storage Areas: 130 sq. ft.
   d. Mechanical Equipment Rooms: 130 sq. ft..
   e. Electrical Equipment Rooms: 130 sq. ft..
   f. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
   b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
   c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Piping materials, including sprinkler specialty fittings.
   2. Pipe hangers and supports.
   3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
   4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
   5. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
   6. Alarm devices, including electrical data.

B. Shop Drawings: Submit detailed working drawings in accordance with NFPA 13 for approval prior to fabrication of piping. Provide a layout and details sufficient to indicate the coordination of the location of sprinkler heads and piping with the ceiling configuration and with the relocation of luminaries and interchangeability of ceiling components. Submit a statement from the sprinkler subcontractor certifying that the design meets the requirements of NFPA 13 and the hydraulic design parameters stated in this specification. The drawings shall be on uniform size sheets no smaller than the Contract Drawings.

C. Hydraulic Calculations: Submit hydraulic calculations as part of the shop drawings. Field test reports and certificates. Prepare hydraulic calculations in accordance with NFPA 13 and the following:
   1. Minimum operating pressure of any sprinkler shall be according to NFPA 13 and UL listing/FM approval.
   2. Pipe friction losses may be calculated by using the nearest foot for all piping over one foot in lengths. Horizontal lengths less than one foot may be neglected. Vertical length less than foot shall be included for elevation purposes only.
   3. Flows shall be calculated to the nearest whole gallon.
   4. Velocity pressures may be neglected.
   5. Velocities in all piping shall not exceed 20 feet per second. Velocities in standpipes must be calculated based on the combined sprinkler flow and hose flow.
   6. Total sprinkler system flow shall not exceed 110 percent of the required flow.
   7. The sprinkler/standpipe risers shall accommodate both the sprinkler and standpipe hose stream flows. Each riser shall accommodate 250 gallons per minute flow for standpipe hose stream.
D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

E. Welding certificates.

F. Fire-hydrant flow test report.

G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include “Contractor’s Material and Test Certificate for Aboveground Piping.”

H. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. As specified in Division 1, Section 017700 “Closeout Procedures”.

B. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

C. As-Built Drawings: Upon completion of the work, the Contractor shall revise the original shop drawings to agree with the construction as actually accomplished. Prepare and submit 4 sets of the as-built drawings.
   1. The drawings shall include all information as required by NFPA 13.
   2. The drawings shall also show the system as installed including all deviations from the approved shop drawings.
   3. The drawings shall be on uniform size sheets no smaller than the Contract Drawings (Minimum 30 inches by 42 inches).
   4. The drawings shall be prepared using AutoCAD 2000 or later. An electronic copy on CD shall be provided.
   5. Final testing shall be conducted after receipt of the as-built drawings.

D. Submit four sets of final hydraulic calculations, manufacturer’s data sheets, Authority Having Jurisdiction acceptance and NFPA certificates.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Company specializing in performing work for this project shall have a minimum of three years related experience, and shall have a sprinkler designer with a minimum NICET Level III certification to supervise completion of the design of this work.
   2. Contractor shall be licensed to complete sprinkler installation by the State of Texas.
   3. Contractor for the work under this section shall be a specialist in this field and have the personal experience, training, skill and the organization to furnish and install a practical working system. If required, the Contractor shall furnish acceptable evidence of having contracted for and installed not less than three systems of comparable size and type to this one, that have served their Owners satisfactorily for not less than three years.
   4. Adequate and competent supervision shall be provided to ensure first class workmanship and installation. All field installation work shall be continuously supervised by a NICET Level II or III sprinkler system technician.
   5. Contractor shall be responsible for all construction techniques required for all fire protection systems specified and shown on the drawings. Work shall be performed by mechanics skilled in the trade.
   6. Contractor shall hold a Certificate of Registration from The State Fire Marshal per the Texas State Sprinkler Rules and Article 5.43-3 Insurance Code. Provide copy of license with bid.
7. Contractor shall be responsible for providing Responsible Managing Employee (R.M.E.) signature and R.M.E. number on shop drawings. Provide R.M.E. license and experience for review.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of sprinkler service.

B. Damage:

1. Protect all unfinished work to prevent damage and furnish protection of all surrounding areas where necessary.

C. Leak Damage:

1. The Contractor shall be responsible during the installation and testing periods of the sprinkler system for any damage to the work of others, to the building or its contents caused by leaks in any equipment, by unplugged or disconnected pipes or fittings, or by overflow. The Contractor shall pay for the necessary replacements or repairs to work of others damaged by such leakage.
2. Water shall not be introduced into the system during conditions where there is danger of freezing or when the building is not closed and heated.

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Through-Penetration Firestop Systems Coordination:

1. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
2. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.
PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized and Black Steel Pipe: ASTM A 53/A 53M. Pipe ends may be factory or field formed to match joining method.


C. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.


E. Malleable- or Ductile-Iron Unions: UL 860.

F. Cast-Iron Flanges: ASME 16.1, Class 125.

G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.


I. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. National Fittings, Inc.
      c. Shurjoint Piping Products.
      d. Tyco Fire & Building Products LP.
      e. Victaulic Company.
   2. Pressure Rating: 175 psig minimum.
   4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.


D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
F. Copper Pressure-Seal Fittings:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Viega; Plumbing & Heating Systems.
   3. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
   4. NPS 2-1/2 to NPS 4: Cast-bronze fitting with EPDM-rubber O-ring seal in each end.

G. Grooved-Joint, Copper-Tube Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. Shurjoint Piping Products.
      c. Victaulic Company.
   2. Grooved-End, Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze castings.
   3. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
   1. Valves shall be UL listed or FM approved.

B. Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. Victaulic Company.
   2. Standard: UL 1091 except with ball instead of disc.
   3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
   4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   5. Valves NPS 3: Ductile-iron body with grooved ends.
C. Bronze Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Fivalco Inc.
      b. Global Safety Products, Inc.
      c. Milwaukee Valve Company.
   2. Standard: UL 1091.
   5. End Connections: Threaded.

D. Iron Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. Fivalco Inc.
      c. Global Safety Products, Inc.
      d. Kennedy Valve; a division of McWane, Inc.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Pratt, Henry Company.
      h. Shurjoint Piping Products.
      i. Tyco Fire & Building Products LP.
      j. Victaulic Company.
   2. Standard: UL 1091.
   4. Body Material: Cast or ductile iron.
   5. Style: Lug or wafer.

E. Check Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. Crane Co.; Crane Valve Group; Crane Valves.
      c. Crane Co.; Crane Valve Group; Jenkins Valves.
      d. Crane Co.; Crane Valve Group; Stockham Division.
      e. Fire-End & Croker Corporation.
      f. Fire Protection Products, Inc.
      g. Fivalco Inc.
      h. Globe Fire Sprinkler Corporation.
      i. Groeniger & Company.
      j. Kennedy Valve; a division of McWane, Inc.
      k. Metraflex, Inc.
      l. Milwaukee Valve Company.
      m. Mueller Co.; Water Products Division.
      n. NIBCO INC.
      o. Potter Roemer.
      p. Reliable Automatic Sprinkler Co., Inc.
      q. Shurjoint Piping Products.
      r. Tyco Fire & Building Products LP.
      s. Victaulic Company.

t. Viking Corporation.

u. Watts Water Technologies, Inc.


4. Type: Swing check.

5. Body Material: Cast iron.

6. End Connections: Flanged or grooved.

F. Bronze OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. United Brass Works, Inc.


5. End Connections: Threaded.

G. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. American Valve, Inc.
   c. Crane Co.; Crane Valve Group; Crane Valves.
   d. Crane Co.; Crane Valve Group; Jenkins Valves.
   e. Crane Co.; Crane Valve Group; Stockham Division.
   f. Hammond Valve.
   g. Milwaukee Valve Company.
   h. Mueller Co.; Water Products Division.
   i. NIBCO INC.
   j. Shurjoint Piping Products.
   k. Tyco Fire & Building Products LP.
   l. United Brass Works, Inc.
   m. Watts Water Technologies, Inc.


4. Body Material: Cast or ductile iron.

5. End Connections: Flanged or grooved.

H. Indicating-Type Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Anvil International, Inc.
   b. Fivalco Inc.
   c. Global Safety Products, Inc.
   d. Kennedy Valve; a division of McWane, Inc.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Shurjoint Piping Products.
h. Tyco Fire & Building Products LP.
i. Victaulic Company.

2. Standard: UL 1091.


4. Valves NPS 2 and Smaller:
   a. Valve Type: Ball or butterfly.
   b. Body Material: Bronze.
   c. End Connections: Threaded.

5. Valves NPS 2-1/2 and Larger:
   a. Valve Type: Butterfly.
   b. Body Material: Cast or ductile iron.
   c. End Connections: Flanged, grooved, or wafer.


I. NRS Gate Valves with Indicator Posts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. American Valve, Inc.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Kennedy Valve; a division of McWane, Inc.
   e. Mueller Co.; Water Products Division.
   f. NIBCO INC.
   g. Tyco Fire & Building Products LP.

2. Standard: UL 262 for valve; UL 789 for indicating post.


4. Body Material: Cast iron with indicator post flange, extension rod and locking device.

5. Stem: Nonrising.

6. End Connections: Flanged or grooved.

2.6 TRIM AND DRAIN VALVES

A. General Requirements:


2. Pressure Rating: 175 psig minimum.

B. Angle, Ball, Globe and Plug Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Affiliated Distributors.
   b. Anvil International, Inc.
   c. Barnett.
   d. Conbraco Industries, Inc.; Apollo Valves.
   e. Fire-End & Croker Corporation.
   f. Fire Protection Products, Inc.
   g. Flowserve.
   h. FNW.
   i. Jomar International, Ltd.
   j. Kennedy Valve; a division of McWane, Inc.
2.7 SPECIALTY VALVES

A. General Requirements:
   2. Pressure Rating:
      a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
   3. Body Material: Cast or ductile iron.
   4. Size: Same as connected piping.
   5. End Connections: Flanged or grooved.

B. Alarm Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AFAC Inc.
      c. Reliable Automatic Sprinkler Co., Inc.
      d. Tyco Fire & Building Products LP.
      e. Venus Fire Protection Ltd.
      f. Victaulic Company.
      g. Viking Corporation.
   3. Design: For horizontal or vertical installation.
   4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
   5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
   6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AFAC Inc.
      b. Reliable Automatic Sprinkler Co., Inc.
      c. Tyco Fire & Building Products LP.
   4. Type: Automatic draining, ball check.
2.8 FIRE-DEPARTMENT CONNECTIONS

A. Flush-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AFAC Inc.
   c. GMR International Equipment Corporation.
   d. Guardian Fire Equipment, Inc.
   e. Potter Roemer.

3. Type: Flush, for wall mounting.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Rectangular, brass, wall type.
11. Escutcheon Plate Marking: Similar to “AUTO SPKR.”

2.9 SPRINKLER SPECIALTY PIPE FITTINGS

A. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AGF Manufacturing Inc.
   b. Reliable Automatic Sprinkler Co., Inc.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.

4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

B. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AGF Manufacturing Inc.
   b. Triple R Specialty.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.
   e. Viking Corporation.

4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. CECA, LLC.
   b. Corcoran Piping System Co.
   c. Merit Manufacturing; a division of Anvil International, Inc.
5. Size: Same as connected piping.
7. Inlet and Outlet: Threaded.

D. Flexible, Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Fivalco Inc.
   b. FlexHead Industries, Inc.
   c. Gateway Tubing, Inc.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
5. Size: Same as connected piping, for sprinkler.

2.10 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFAC Inc.
3. Reliable Automatic Sprinkler Co., Inc.
4. Tyco Fire & Building Products LP.
5. Venus Fire Protection Ltd.

B. General Requirements:

C. Automatic Sprinklers with Heat-Responsive Element:
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
D. Sprinkler Finishes:
   1. Chrome plated.
   2. Bronze.
   3. Painted.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: Chrome-plated steel, two piece, with 1-inch vertical adjustment.
   2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Reliable Automatic Sprinkler Co., Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
      d. Viking Corporation.
   2. Standard: UL 199.
   3. Type: Wire cage with fastening device for attaching to sprinkler.

2.11 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
      d. Viking Corporation.
   2. Standard: UL 753.
   3. Type: Mechanically operated, with Pelton wheel.
   5. Size: 10-inch diameter.
   6. Components: Shaft length, bearings, and sleeve to suit wall construction.
   8. Outlet: NPS 1 drain connection.

C. Water-Flow Indicators:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ADT Security Services, Inc.
      b. McDonnell & Miller; ITT Industries.
      c. Potter Electric Signal Company.
      d. System Sensor; a Honeywell company.
      e. Viking Corporation.
      f. Watts Industries (Canada) Inc.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

5. Type: Paddle operated.


7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AFAC Inc.
   b. Barksdale, Inc.
   c. Detroit Switch, Inc.
   d. Potter Electric Signal Company.
   e. System Sensor; a Honeywell company.
   f. Tyco Fire & Building Products LP.
   g. United Electric Controls Co.
   h. Viking Corporation.


3. Type: Electrically supervised water-flow switch with retard feature.


5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Fire-Lite Alarms, Inc.; a Honeywell company.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Potter Electric Signal Company.
   d. System Sensor; a Honeywell company.


3. Type: Electrically supervised.


5. Design: Signals that controlled valve is in other than fully open position.

F. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. System Sensor; a Honeywell company.


3. Type: Electrically supervised.


5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.12 PRESSURE GAGES

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

1. AMETEK; U.S. Gauge Division.

2. Ashcroft, Inc.
4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 250 psig minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 21 Section "Facility Fire-Suppression Water-Service Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 Section "Facility Fire-Suppression Water-Service Piping."

3.3 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved shop drawings for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.
H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Pressurize and check preaction sprinkler system piping and air compressors.

N. Fill sprinkler system piping with water.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

K. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

L. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

M. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.

N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:
   1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.6 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

3.7 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.
B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.8 IDENTIFICATION
A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section “Identification for Electrical Systems.”

3.9 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. Tests and Inspections:
   1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   4. Energize circuits to electrical equipment and devices.
   5. Coordinate with fire-alarm tests. Operate as required.
   6. Coordinate with fire-pump tests as applicable. Operate as required.
   7. Verify that equipment hose threads are same as local fire-department equipment.
C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.10 CLEANING
A. Clean dirt and debris from sprinklers.
B. Remove and replace sprinklers with paint other than factory finish.

3.11 DEMONSTRATION
A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps as applicable.

3.12 PIPING SCHEDULE
A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe.
B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   4. Type L, hard copper tube with plain ends; cast or wrought-copper solder-joint fittings; and brazed joints.
5. Type L, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   3. Standard-weight, black-steel pipe with cut or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   5. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   6. Type L, hard copper tube with plain ends; cast or wrought-copper solder-joint fittings; and brazed joints.
   7. Type L, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
   8. Type L, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

3.13 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
   4. All sprinkler heads installed within 7 feet of the floor or otherwise subject to mechanical damage shall be equipped with sprinkler guard.
   5. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
   1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
   2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
   3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
   4. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13
SECTION 22 05 00  COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   7. Grout.
   8. Plumbing demolition.

1.3 DEFINITIONS
A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
F. The following are industry abbreviations for plastic materials:
   1. PVC: Polyvinyl chloride plastic.
G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS
A. Product Data: For the following:
   1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

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

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

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section “Access Doors and Frames.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

C. Solvent Cements for Joining Plastic Piping:
   1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 TRANSITION FITTINGS
A. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer’s Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
   1. Available Manufacturers:
      a. Elson Thermoplastics.

B. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
   1. Available Manufacturers:
      a. NIBCO INC.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Available Manufacturers:
      c. Zurn Industries, Inc.; Wilkins Div.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Available Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

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

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
B. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

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

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Equipment to Be Removed: Disconnect and cap services and remove equipment.

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

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

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

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

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

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

F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      b. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
      c. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
      d. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Fill annular space of sleeve with steel wool and flexible sealant.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Edit pipe size range in first two subparagraphs below to suit Project. Confirm that PVC materials are allowed for sleeves by fire authorities having jurisdiction.
      b. Steel Pipe Sleeves: For pipes smaller than NPS 6.
      c. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
N. Fire-Border Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with UL listed firestopping assembly equal to 3M. Refer to Division 07 Section "Penetration Firestopping" for materials.
O. Verify final equipment locations for roughing-in.
P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
3.3 PIPING JOINT CONSTRUCTION
A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
   3. PVC Non-pressure Piping: Join according to ASTM D 2855.

G. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

H. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

C. Field Welding: Comply with AWS D1.1.

3.6 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 22 05 00
SECTION 22 05 23  GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following general-duty valves:
   I. Copper-alloy ball valves.
   II. Bronze swing check valves.

B. Related Sections include the following:
   I. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and charts.
   II. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:
   I. CWP: Cold working pressure.
   II. PTFE: Polytetrafluoroethylene plastic.
   III. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from a single source from single manufacturer.

B. ASME Compliance: ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   I. Protect internal parts against rust and corrosion.
   II. Protect threads, flange faces, grooves, and weld ends.
   III. Block check valves in either closed or open position.
   IV. Set ball and plug valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
I. Maintain valve end protection.
II. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

E. Valve Actuators:
   I. Handwheel: For valves other than quarter-turn types.
   II. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
   III. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

F. Extended Valve Stems: On insulated valves.

G. Valve-End Connections:
   II. Valve Grooved Ends: AWWA C606.
   III. Solder Joint: With sockets according to ASME B16.18.
      a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
   IV. Threaded: With threads according to ASME B1.20.1.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 COPPER-ALLOY BALL VALVES

A. Copper-Alloy Ball Valves, General: MSS SP-110.

B. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; threaded ends; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.3 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves, General: MSS SP-80, Type 3.

B. Multi-directional; Class 125, ASTM B 62 bronze body construction with bronze disc; threaded ends; and 200-psig CWP rating.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   I. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
   I. Shutoff Service: Ball, butterfly, gate, or plug valves.
   II. Pump Discharge: Spring-loaded, lift-disc check valves.

B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.

C. Domestic Water Piping: Use the following types of valves:
   I. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
   II. Bronze Swing Check Valves: Class 125, bronze disc, 200-psig CWP rating.

D. Select valves, except wafer and flangeless types, with the following end connections:
   I. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends.
   II. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
   III. For Grooved-End, Copper Tubing: Valve ends may be grooved.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.
E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow with hinge pin level.

3.4 JOINT CONSTRUCTION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 22 05 23
SECTION 22 05 29 HANGERS & SUPPORTS FOR PLUMBING PIPING & EQUIPMENT

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following hangers and supports for plumbing system piping and equipment:
      1. Trapeze pipe hangers.
      2. Metal framing systems.
      3. Thermal-hanger shield inserts.
      4. Fastener systems.
      5. Pipe positioning systems.

1.3 DEFINITIONS
   A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
   B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS
   A. Product Data: For the following:
      1. Adjust list below to suit Project.
      2. Thermal-hanger shield inserts.
      3. Powder-actuated fastener systems.
      4. Pipe positioning systems.

PART 2 - PRODUCTS

2.1 TRAPEZE PIPE HANGERS
   A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.2 METAL FRAMING SYSTEMS
   A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
   B. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
   C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 THERMAL-HANGER SHIELD INSERTS
   A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

2.6 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

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

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.
F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

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

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Verify suitability of fasteners in two subparagraphs below for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other
accessories.

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

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional
attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at
changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms
and install reinforcing bars through openings at top of inserts.

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

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe
deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

L. Insulated Piping: Comply with the following:
   1. Specify parts as galvanized or painted, as required, in first three subparagraphs and associated
      subparagraphs below. Other materials are available in place of wooden blocks.
   2. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with
         clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
   3. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill
      interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate
         for pipe NPS 4 and larger if pipe is installed on rollers.
   4. High compressive-strength inserts may permit use of shorter shields or shields with less arc span.
      Edit first subparagraph and associated subparagraph below to suit Project.
   5. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall
      span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate
         for pipe NPS 4 and larger if pipe is installed on rollers.
   6. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
      b. NPS 4: 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
   7. Pipes NPS 8 and Larger: Include wood inserts.
   8. Insert Material: Length at least as long as protective shield.
   9. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

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

END OF SECTION 22 05 29
PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Pipe labels.
      2. Valve tags.

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

1.4 COORDINATION
   A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
   B. Coordinate installation of identifying devices with locations of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 PIPE LABELS
   A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
   B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
   C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
      1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
      2. Lettering Size: At least 1-1/2 inches.

2.2 VALVE TAGS
   A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
      1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
      2. Fasteners: Stainless Steel or Brass S-hook.
B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Other valve-tag sizes, shapes, colors, and letter colors may be available if required.
2. Valve-Tag Size and Shape:
   a. Cold Water: 2 inches.
   b. Hot Water: 2 inches.
3. Valve-Tag Color:
   b. Hot Water: Natural.
4. Letter Color:
   b. Hot Water: Black.

END OF SECTION 22 05 53
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Flexible elastomeric.
      b. Mineral fiber.
   2. Adhesives.

B. Related Sections include the following:
   1. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Submittals shall provide documentation that products contain no added formaldehyde and that all adhesives, mastics, and sealants meet the most current VOC limits of SCAQMD r1168.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. All adhesives, mastics, and sealants shall be required to meet the most current VOC limits of SCAQMD r1168.

D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

H. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Fibrex Insulations Inc.; Coreplus 1200.
      b. Johns Manville; Micro-Lok.
      c. Knauf Insulation; 1000(Pipe Insulation.
      d. Manson Insulation Inc.; Alley-K.
      e. Owens Corning; Fiberglas Pipe Insulation.
   2. ASJ requires field-applied adhesive and staples. ASJ with SSL does not require field-applied adhesive and staples, resulting in reduced installation labor.
3. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.


2.3 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.4 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket.
Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

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

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 PIPING INSULATION SCHEDULE, GENERAL
A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.9 PIPING INSULATION SCHEDULE

A. Domestic Cold Water (interior):
   1. NPS 4 and Smaller: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 2 and Smaller: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Roof Drain and Overflow Piping and Drain Bodies (Including Vertical Risers in Inaccessible Chases):
   1. All Pipe Sizes:
      a. Flexible Elastomeric: 1 inch thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

END OF SECTION 22 07 00
SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes domestic water piping

1.3 SUBMITTALS
   A. Product Data: For pipe, tube, fittings, and couplings
   C. Field quality-control test reports.

1.4 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
   B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
      1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS
   A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 COPPER TUBE AND FITTINGS
   A. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
      2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
      3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
2.4 VALVES
A. Bronze and cast-iron, general-duty valves are specified in Division 22 Section "General Duty Valves for Plumbing Piping."

PART 3 - EXECUTION

3.1 PIPE AND FITTING APPLICATIONS
A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
B. Flanges may be used on aboveground piping, unless otherwise indicated.
C. Underground water-service piping NPS 3/4 to NPS 3 shall be any of the following:
   1. Soft copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
D. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
   1. All pipe sizes: Hard copper tube, Type L; copper pressure fittings; and soldered joints.

3.2 VALVE APPLICATIONS
A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves.
C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
   1. Install hose-end drain valves at low points in water mains, risers, and branches.
D. Install balancing valve in each hot-water circulation return branch. Set balancing valves partly open to restrict but not stop flow. Use ball valves.

3.3 PIPING INSTALLATION
A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
B. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
C. Bury piping with depth of cover over top at least 30 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:
   1. Under Driveways: With at least 36 inches cover over top.

3.4 JOINT CONSTRUCTION
A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; 4 percent silver, 96 percent tin; and ASTM B 828 procedure, unless otherwise indicated.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices are specified in Division 22 Section "Hangers and Supports." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.

B. Install supports according to Division 22 Section "Hangers and Supports."

C. Install supports within 12 inches of all elbows and tees.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to existing pipe with shutoff valve, and extend and connect to the following:
   1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."

3.7 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 150 psig. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 22 11 16
SECTION 22 11 19  DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Backflow preventers.
   2. Hose bibbs.
   3. Drain valves.
   5. Trap-seal primer valves.
   6. Trap-seal primer systems.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NSF Compliance: Comply with NSF 61, “Drinking Water System Components – Health Effects; Sections 1 through 9.”

1.4 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
   2. Body: Bronze.
   4. End Connections: Threaded.
   5. Configuration: Designed for horizontal, straight-through flow.
   6. Operation: Continuous-pressure applications.
   7. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.
8. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet.

2.2 HOSE BIBBS

A. Hose Bibbs 'HB':
   4. Supply Connections: NPS 1/2 or NPS 3/4 threaded inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   7. Vacuum Breaker: Integral or field-installation, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.

2.3 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: 400-psig minimum CWP.
   4. Body: Copper alloy.
   5. Ball: Chrome-plated brass.
   8. Inlet: Threaded or solder joint.

2.4 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AMTROL, Inc.
      b. Josam Company.
      c. MIFAB, Inc.
      d. PPP Inc.
      e. Sioux Chief Manufacturing Company, Inc.
      g. Tyler Pipe; Wade Div.
      h. Watts Drainage Products Inc.
      i. Zurn Plumbing Products Group; Specification Drainage Operation.
   3. Type: Metal bellows.
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.5 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:
1. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. PPP Inc.
   b. Sioux Chief Manufacturing Company, Inc.
   d. Watts Drainage Products Inc.

2. **Standard:** ASSE 1018.
3. **Pressure Rating:** 125 psig minimum.
4. **Body:** Bronze.
5. **Inlet and Outlet Connections:** NPS ½ (DN 15) threaded, union.
6. **Gravity Drain Outlet Connection:** NPS ½ (DN 15) threaded.
7. **Finish:** Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

### 2.6 TRAP-SEAL PRIMER SYSTEMS

**A. Trap-Seal Primer Systems**

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

2. **Standard:** ASSE 1044.
3. **Piping:** NPS ¾, ASTM B 88, Type L (DN 20, ASTM B 88M, Type B); copper, water tubing.
4. **Cabinet:** Surface-mounting steel box with stainless steel cover.
5. **Electric Controls:** 24-hour timer, solenoid valve, and manual switch for 120 V AC power.
6. **Vacuum Breaker:** ASSE 1001.
7. **Number of Outlets:** Per number of connected fixtures. Refer to drawings.
8. **Size Outlets:** NPS ½ (DN 15)

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

**A.** Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

**B.** Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. **Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.**

2. **Do not install bypass piping around backflow preventers.**

**C.** Install water hammer arresters in water piping according to PDI-WH 201.

**D.** Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

**E.** Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.
F. Connections:
   1. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
   2. Ground equipment according to Division 26 Section, “Grounding and Bonding for Electrical Systems.”
   3. Connect wiring according to Division 26 Section, “Low-Voltage Electrical Power Conductors and Cables.”

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device’s reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION 22 11 19
SECTION 22 11 23
DOMESTIC WATER PUMPS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. In-line, seal-less centrifugal pumps.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Retain shipping flange protective covers and protective coatings during storage.
B. Protect bearings and couplings against damage.
C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 IN-LINE, SEAL-LESS CENTRIFUGAL PUMPS
A. Basis-of-Design Product: Subject to compliance with requirements, provide Grundfos or comparable product by one of the following:
   1. Armstrong Pumps Inc.
2. Bell & Gossett
3. TACO Incorporated.

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, seal-less, overhung-impeller centrifugal pumps.

C. Pump Construction:
1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Casing: Bronze, with threaded or companion-flange connections.
4. Motor: Single speed, unless otherwise indicated.

D. Capacities and Characteristics:
2. Total Dynamic Head: 10 feet.
4. Maximum Continuous Operating Temperature: 220 deg F.
5. Inlet and Outlet Size: 3/4 NPS.
7. Pump Control: Thermostat and Timer.
9. Electrical Characteristics:
   a. Volts: 120.
   c. Hertz: 60.
   d. Full-Load Amperes: 0.4.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22.05.13 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F.
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
7. Settings: Start pump at 110 deg F and stop pump at 120 deg F.

B. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.
2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120-V ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

C. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.
   1. Type: Adjustable time-delay relay.
   2. Range: Up to five minutes.
   4. Enclosure: NEMA 250, Type 4X.
   5. Operation of Pump: On or off.
   6. Transformer: Provide if required.
   8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.
B. Install in-line, seal-less centrifugal pumps with shaft horizontal unless otherwise indicated.
C. Install horizontally mounted, in-line, centrifugal pumps with shaft(s) horizontal.
D. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.
E. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.
   1. Comply with requirements for vibration isolation devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
   2. Comply with requirements for hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
F. Install thermostats in hot-water return piping.
G. Install timers on wall near pump.
H. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to pumps to allow service and maintenance.
C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
   1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
      a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
      b. Comply with requirements for flexible connectors specified in Section 22 11 16 "Domestic Water Piping."
   2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Section 22 11 19 "Domestic Water Piping Specialties."

D. Connect thermostats, time-delay relays, and timers to pumps that they control.

E. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Set thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
   5. Perform the following startup checks for each pump before starting:
      a. Verify bearing lubrication.
      b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
      c. Verify that pump is rotating in the correct direction.
   6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   7. Start motor.
   8. Open discharge valve slowly.
   9. Adjust temperature settings on thermostats.
   10. Adjust timer settings.

3.6 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23
SECTION 22 13 16  SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes the following for soil, waste, and vent piping inside the building:
      1. Pipe, tube, and fittings.
      2. Special pipe fittings.

1.3 PERFORMANCE REQUIREMENTS
   A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1.4 SUBMITTALS
   A. Product Data: For pipe, tube, fittings, and couplings.
   B. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
      1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work including, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS
   A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
   B. All pipe and fittings shall be manufactured in the United States of America.
2.3 COPPER TUBE AND FITTINGS
   A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
   B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
   C. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.4 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS
   A. Pipe and Fittings: ASTM A 74, Service class.
   B. Gaskets: ASTM C 564, rubber.

2.5 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS
   A. Pipe and Fittings: ASTM A 888 or CISPI 301.
   B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
         a. Available Manufacturers:
            1) Clamp-All Corp.
            2) Mission Rubber Co.
            3) Tyler Pipe; Soil Pipe Div.

2.6 SPECIALTY PIPE FITTINGS
   A. Transition Couplings:
      1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
      2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
      3. Unshielded, Non-pressure Transition Couplings:
         a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
            2) Fernco Inc.
            3) Mission Rubber Company; a division of MCP Industries, Inc.
            4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
         c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
         d. Sleeve Materials:
            2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      2) Mission Rubber Company; a division of MCP Industries, Inc.
   c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation where specified.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants.
cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Drain: 1 percent downward in direction of flow.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install aboveground copper tubing according to CDA’s “Copper Tube Handbook.”

N. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 13 19 “Sanitary Waste Piping Specialties.”

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 00.

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 00.

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 00.

S. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."


3.2 JOINT CONSTRUCTION

A. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Shielded, non-pressure transition couplings.
3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 “Hangers and Supports for Plumbing Piping and Equipment.”

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 3 and smaller: 60 inches with 1/2-inch rod.
   2. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   3. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   4. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.
   6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer’s written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
C. Connect drainage and vent piping to the following:
   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping.
system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping shall be any of the following:
   1. Copper DWV tube, copper drainage fittings, and soldered joints.
   2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

C. Aboveground, vent piping shall be any of the following:
   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

D. Underground, soil, waste, and vent piping shall be any of the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

END OF SECTION 22 13 16
SECTION 22 13 19  
DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1  RELATED DOCUMENTS

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

1.2  SUMMARY

A. This Section includes the following drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
   3. Miscellaneous drainage piping specialties.

1.3  SUBMITTALS

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

1.4  QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1  CLEANOUTS

A. Exposed Metal Cleanouts:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Tyler Pipe 8560-E or a comparable product by one of the following:
      c. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk cast-iron plug.

B. Metal Floor Cleanouts:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Tyler Pipe 6000 or a comparable product by one of the following:
      c. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule threaded, adjustable housing cleanout.
   3. Size: Same as connected branch.
   4. Type: Cast-iron soil pipe with cast-iron ferrule with threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Closure: Brass plug with straight threads and gasket.
10. Frame and Cover Shape: Square in tile areas, round with carpet marker in carpeted areas.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Size: Same as connected branch, up to 4 inches, 4 inches for branches larger than 4 inches.

C. Cast-Iron Wall Cleanouts:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Tyler Pipe 8560-E with 8480R or a comparable product by one of the following:
   c. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, stainless-steel cover plate with screw. FLOOR DRAINS

D. Floor Drains FD'A:
1. Basis-of-Design Product: Subject to compliance with requirements, provide JR Smith 2005L with 5"x5" NB top, cast iron body, or a comparable product by one of the following:
   c. Tyler Pipe; Wade Div.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
3. Outlet: 4" Bottom, unless otherwise noted. Refer to drawings for connecting pipe sizes.
4. Trap Material: Cast iron.
6. Trap Features: Trap-seal primer valve drain connection

E. Floor Sink FS:
1. Basis-of-Design Product: Subject to compliance with requirements, provide JR Smith 9642-8x8x4, Stainless Steel, Square floor sink, Stainless Steel Strainer, ½ Stainless Grate. Trap Primer connection or a comparable product by one of the following:
   c. Tyler Pipe; Wade Div.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
3. Outlet: 4" Bottom, unless otherwise noted. Refer to drawings for connecting pipe sizes.
4. Trap Material: Cast iron.
6. Trap Features: Trap-seal primer valve drain connection
2.2 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:
   1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
   2. Size: Same as connected waste piping.
      a. NPS 2: 4-inch-minimum water seal.
      b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings:
   1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
   2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Basic Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

G. Install deep-seal traps on floor drains and other waste outlets, if indicated.

H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION  22 13 19
SECTION 22 14 13  FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS
A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.6 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.7 PROJECT CONDITIONS
A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of storm-drainage service.
   2. Do not proceed with interruption of storm-drainage service without Owner's written permission.
PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. All pipe and fittings shall be manufactured in the United States of America.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service classes.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ANACO-Husky.
      b. Clamp-All Corp.
      c. MIFAB, Inc.
      d. Mission Rubber Company; a division of MCP Industries, Inc.
      e. Tyler Pipe.
   2. Standards: ASTM C 1540.
   3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
   3. Shielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
         2) Mission Rubber Company; a division of MCP Industries, Inc.
      c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   4. Pressure Transition Couplings:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2) Dresser, Inc.
3) EBAA Iron, Inc.
4) Ford Meter Box Company, Inc. (The)
5) JCM Industries, Inc.
6) Romac Industries, Inc.
7) Smith-Blair, Inc.; a Sensus company.
8) Viking Johnson; c/o Mueller Co.

c. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Manufacturer's standard.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
   1. Building Storm Drain: 1 percent downward in direction of flow.
   2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow unless otherwise noted.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

N. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
   2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION


3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: **Shielded**, nonpressure transition couplings.
   4. In Underground Force-Main Piping:
      a. NPS 2 and Larger: Pressure transition couplings.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install **carbon-steel** pipe hangers for horizontal piping in noncorrosive environments.
   2. Install **stainless-steel** pipe hangers for horizontal piping in corrosive environments.
3. Install **carbon-steel** pipe support clamps for vertical piping in noncorrosive environments.

4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical Piping: MSS Type 8 or Type 42, clamps.

6. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3 and smaller: 60 inches with 1/2-inch rod.
   2. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   3. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   4. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.

C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.

D. Underground storm drainage piping shall be **any of** the following:

1. **Service** class, cast-iron soil pipe and fittings; **gaskets; and gasketed** joints.

END OF SECTION 22 14 13
SECTION 22 14 23
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section Includes:
   1. Roof drains.
   2. Overflow Drains.
   3. Miscellaneous storm drainage piping specialties.
   5. Trench drains.
   6. Catch Basins.
   7. Through-penetration firestop assemblies.
   8. Flashing materials.

B. Related Sections include the following:
   1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, General-Purpose Roof Drains RD:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      b. MIFAB, Inc.
      d. Tyler Pipe.
      e. Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Light Commercial Products Operation.
      g. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.6.4, for general-purpose roof drains.
4. Pattern: Roof drain. Combination Flashing Ring and Gravel Stop: **Required**.
5. Outlet: **Bottom**.
6. Extension Collars: **Not required**.
7. Underdeck Clamp: **Required**.
8. Expansion Joint: **Not required**.
9. Sump Receiver Plate: **Not required**.
10. Dome Material: **Cast iron**.
11. Wire Mesh: **Not required**.
12. Vandal-Proof Dome: **Not required**.

B. Cast-Iron, Overflow Roof Drains OFD:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. MIFAB, Inc.
   d. Tyler Pipe.
   e. Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Light Commercial Products Operation.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
4. Pattern: Roof drain with adjustable standpipe.
5. Combination Flashing Ring and Gravel Stop: **Required**.
6. Outlet: **Bottom**.
7. Extension Collars: **Not required**.
8. Underdeck Clamp: **Required**.
9. Expansion Joint: **Not required**.
10. Sump Receiver Plate: **Not required**.
11. Dome Material: **Cast iron**.
12. Wire Mesh: **Not required**.
13. Vandal-Proof Dome: **Not required**.

### 2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Conductor Nozzles DSN:
1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

### 2.3 CLEANOUTS

A. Refer to Division 22 Section “Sanitary Waste Piping Specialties” for cleanout requirements.

### 2.4 TRENCH DRAINS

A. Trench Drains:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. MIFAB, Inc.
   d. Tyler Pipe.
e. Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Trench Drain TD'A':
2. Body Material: Ductile or gray iron.
3. Flange: Anchor.
5. Outlet: Bottom.
8. Dimensions of Frame and Grate: 12”x36”.

C. Trench Drain TD'B':
2. Body Material: Ductile or gray iron.
3. Flange: Anchor.
5. Outlet: Bottom.
8. Dimensions of Frame and Grate: 6”x48”.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ProSet Systems Inc.
2. Standard: ASTM E 814, for through-penetration firestop assemblies.
3. Certification and Listing: UL 1479 for through-penetration firestop assemblies.
4. Size: Same as connected pipe.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
7. Special Coating: Corrosion resistant on interior of fittings.

2.6 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft..

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.
E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
   1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Set overflow drain standpipe 2" above roof deck low point.

B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

C. Install cleanouts in aboveground piping and building drain piping according to the following unless otherwise indicated:
   1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   3. Locate cleanouts at minimum intervals of 100 feet.
   4. Locate cleanouts at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

H. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

I. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

J. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
3.3 FLAShING INSTAllATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23
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. This Section includes the following conventional plumbing fixtures and related components:
   1. Water Closets
   2. Urinals
   3. Lavatories
   4. Sinks
   5. Electric Water Coolers
   6. Mop Basins
   7. Hydrants

B. Related Sections include the following:
   1. Division 22 Specialties Section for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.


C. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
D. Comply with the following applicable standards and other requirements specified for lavatory faucets:
   1. Faucets: ASME A112.18.1.

E. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

F. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Off-Floor Fixture Supports: ASME A112.6.1M.

PART 2 - PRODUCTS

2.1 WATER CLOSETS

A. Water Closets:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide products listed or a comparable product.
   2. Water Closet WC'A'
      a. Bowl: Sloan ST-2029, 1.28 gpf, bottom outlet, top spud, elongated bowl, siphon jet, 17” height, TAS Compliant with bolt covers.
      b. Flush valve: Sloan Royal G2 8111-1.28, battery, sensor, override, 11-1/2” riser.
      c. Seat: Bemis 1955SSC white solid plastic open front.
   3. Water Closet WC'D'
      d. Bowl: Sloan ST-2459, 1.28 gpf, wall outlet, siphon jet, TAS compliant for grades 6-8, with closet carrier fitting and chrome mounting bolts and bolt caps. Refer to Architect drawings for mounting height.
         a. Flush valve: Sloan Royal G2 8111-1.28, battery, sensor, override, 11-1/2” riser.
         b. Seat: Bemis 1955SSC white solid plastic open front.
         c. Carrier: Wade W-310-HD, W-330-HD, or W-340-HD adjustable carrier with faceplate and support hardware to comply with ASME A112.6.1M at 500 Lbs maximum test load.

2.2 URINALS

A. Urinals
   1. Basis-of-Design Product: Subject to compliance with requirements, provide products listed or a comparable product.
   2. Urinal U - Top Spud, TAS
      a. Fixture: Sloan SU-1009 vitreous china, wall hung, 0.125 gpf siphon jet, with chair carrier, and 3/4” top spud. Refer to Architect drawings for mounting height.
      b. Flush valve: Sloan Regal G2 8186-0.125, battery, sensor, override, 11-1/2” riser.
2.3 LAVATORIES

A. Lavatory L'A':

1. Basis-of-Design Product: Subject to compliance with requirements, provide products listed or a comparable product.
   a. Fixture: American Standard Lucerne 0355.004 vitreous china 20" x 18" for concealed arms, with 4" drillings. TAS compliant.
   b. Supply: T&S B-0831-VF05 Self-Closing Metering Faucet, vandal resistant, 0.5 GPM outlet.
   c. Tailpiece: Kohler K-7715 perforated grid strainer.
   d. P-trap: Kohler K-8998 with tubing waste and escutcheon.
   e. Stops, risers: NPS 3/8 chrome-plated copper with ¼ turn loose key stops. Stops shall be all brass construction.
   f. Carrier: Wade chair carrier with concealed arms.
   g. Insulation: Truebro 102W insulation for p-trap, offset tailpiece, and hot and cold supplies.
   h. Thermostatic Mixing Valve: Watts LFUSG-B-SC, ASSE 1070 listed, lead free brass 4-port, "H" pattern body with satin chrome finish. Valve shall be provided with integral check valves and locking adjustment nut for temperature control. Set at 110°F.

2.4 WASHSTATIONS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the specified product or a comparable product by one of the following (other manufacturers will require owner review and approval before bidding):

   1. Sloan
   2. Intersan

B. Washstation S'C' – 3 Stations, TAS Compliant

1. Basis-of-Design Product: Subject to compliance with requirements, provide products listed or a comparable product.
   b. Supply: Three (3) T&S B-0805-VF05 Self-Closing Metering Faucet, vandal resistant, 0.5 GPM outlet.
   c. Tailpiece: Two (2) Kohler K-7715 perforated grid strainer.
   d. P-trap: Kohler K-8998 with tubing waste and escutcheon.
   e. Stops, risers: NPS 3/8 chrome-plated copper with ¼ turn loose key stops. Stops shall be all brass construction. Provide one stop per supply.
   f. Carrier: Provide with manufacturer's wall mounting bracket and install per manufacturers support and installation requirements.
   g. Thermostatic Mixing Valve: Watts LFUSG-B-SC, ASSE 1070 listed, lead free brass 4-port, "H" pattern body with satin chrome finish. Valve shall be provided with integral check valves and locking adjustment nut for temperature control. Set at 110°F.

2.5 SINKS

A. Sink S'A':

1. Basis-of-Design Product: Subject to compliance with requirements, provide products listed or a comparable product.
a. Fixture: Elkay LRAD3122603, 31” x 22” single 6” deep compartment, 18 gauge type 304 stainless steel, self rimming sink with three (3) faucet holes on 4” centers.

b. Supply: B-0892-133XCRWS, 4” centerset deck mount polished chrome plated brass body faucet, 5-3/4” swivel/rigid gooseneck, 1.5 GPM aerator, ceramic cartridges with check valves, and 4” wrist action handles. NSF 61 and ADA compliant.


d. Strainer: Kohler K-8801 strainer and crumb cup.

e. P-trap: Kohler K-9000 with tubing waste and escutcheon.

f. Stops, risers: NPS 3/8 chrome-plated copper with ¼ turn loose key stops. Stops shall be all brass construction.

g. Thermostatic Mixing Valve: Watts LFUSG-B-SC, ASSE 1070 listed, lead free brass 4-port, “H” pattern body with satin chrome finish. Valve shall be provided with integral check valves and locking adjustment nut for temperature control. Set at 110°F.

B. Sink S’B’:

1. Basis-of-Design Product: Subject to compliance with requirements, provide products listed or a comparable product.

   a. Fixture: Just NSFB-148, 51” x 27-1/2” single 12” deep compartment, 14 gauge type 304 stainless steel, utility sink with 12” backsplash and two (2) faucet holes on 8” centers. Supported on four (4) 1-5/8” OD 16 gauge stainless steel tubular legs with fully enclosed gussets and adjustable bullet feet.

   b. Supply: T&S Brass B-0331-CR4-L22, 8” wall mount polished chrome plated brass body faucet, 5-3/4” swivel/rigid gooseneck with 2.2 GPM laminar flow device, ceramic cartridges with check valves, and 4” wrist action handles. NSF 61 and ADA compliant.

   c. Tailpiece, strainer: Just J-35 stainless steel strainer with crumb cup and 4” long chrome plated brass tailpiece.

   d. P-trap: Kohler K-9000 with tubing waste and escutcheon.

   e. Stops, risers: NPS 3/8 chrome-plated copper with ¼ turn loose key stops. Stops shall be all brass construction.

   f. Thermostatic Mixing Valve: Watts LFUSG-B-SC, ASSE 1070 listed, lead free brass 4-port, “H” pattern body with satin chrome finish. Valve shall be provided with integral check valves and locking adjustment nut for temperature control. Set at 110°F.

2.6 ELECTRIC WATER COOLERS

B. Basis-of-Design Product: Subject to compliance with requirements, provide the specified product or a comparable product by one of the following:

   1. Halsey Taylor.

   2. Elkay Manufacturing Co.

C. EWC – Dual Station with Bottle Fill, TAS Compliant

   1. Fixture: Halsey Taylor HTHB-HVRGRN8BL-WF bi-level with stainless steel receptors and cabinet and bottle filling station. Provide LKAPREZL cane apron where fixture is not fully recessed in an alcove. Refer to Architect drawings for mounting height.

   2. P-trap: Elkay LK500 chrome plated brass with tubing waste and escutcheon.

2.7 MOP BASINS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product or a comparable product by one of the following:

1. Acorn Engineering Company.
2. Crane Plumbing, L.L.C./Fiat Products.
3. Stern-Williams Co., Inc.
4. Swan Corporation (The).
5. Zurn Plumbing Products Group; Light Commercial Operation.

B. Mop Basins MB

1. Fixture: Stern-Williams SB-902 24x24x12 precast terrazzo, 3" integral drain body, stainless steel cap & tiling flange on two sides.
3. Accessories: Stern Williams T-35 hose and wall hook, T-40 stainless steel mop hanger and BP 20 ga. Type 304 stainless steel splash panels.

2.8 Wall Boxes

A. Refrigerator Box RB / Ice Machine Box IM

1. Fixture: Guy Gray MIB1HAAB recessed steel box with 1/2" FIP inlet x 1/4" OD outlet, quarter-turn valve, water hammer arrestor, and white powder coat finish.

2.9 Hydrants

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product or a comparable product by one of the following:

1. Woodford
2. MAPA

B. Roof Hydrant RH

1. Fixture: Woodford SRH-MS Freezeless roof hydrant with deck clamp and vacuum breaker.

C. Wall Hydrant WH

1. Fixture:
   a. Exterior: Woodford B-65 Freezeless wall hydrant with brass box and door, keyed with vacuum breaker.
   b. Interior: Woodford MB24 with Model 24P-3/4 faucet, composite box, stainless steel door, and fascia. Include with loose tee key lock for door and vacuum breaker.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

C. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

D. Install wall-mounting fixtures with tubular waste piping attached to supports.

E. Install counter-mounting fixtures in and attached to casework.

F. Install fixtures level and plumb according to roughing-in drawings.

G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

J. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

N. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."

O. Set shower in leveling bed of cement grout. Grout is specified in Division 15 Section "Basic Mechanical Materials and Methods."
P. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section “Joint Sealants.”

3.3 CONNECTIONS
A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

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

3.5 ADJUSTING
A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
B. Adjust water pressure at flushometer valves to produce proper flow and stream.
C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING
A. Clean fixtures, faucets, and other fittings with manufacturers’ recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.
B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION
A. Provide protective covering for installed fixtures and fittings.
B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 40 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 CHECKING DOCUMENTS:

   A. The drawings and the specifications are numbered consecutively. The Contractor shall check the drawings and specifications thoroughly and shall notify the Architect of any discrepancies or omissions of sheets or pages. Upon notification, the Architect will promptly provide the Contractor with any missing portions of the drawings or specifications. No discrepancies or omissions of sheets or pages of the contract documents will relieve the Contractor of his duty to provide all work required by the complete contract documents.

1.3 SUMMARY

   A. This Section includes the following:
      1. General Provisions for Construction
      2. Piping materials and installation instructions common to most piping systems.
      3. Sleeves.
      4. Escutcheons.
      5. Grout.
      6. Equipment installation requirements common to equipment sections.
      7. Painting and finishing.
      8. Concrete bases.
     10. Close-out Documents and Requirements

1.4 TERMINOLOGY

   A. Whenever the words "furnish", "provide", "furnish and install," "provide and install", and/or similar phrases occur, it is the intent that the materials and equipment described be furnished, installed and connected under this Division of the Specifications, complete for operation unless specifically noted to the contrary.

   B. Where a material is described in detail, listed by catalogue number or otherwise called for, it shall be the Contractor's responsibility to furnish and install the material.

   C. The use of the word "shall" conveys a mandatory condition to the contract.

   D. "This section" always refers to the section in which the statement occurs.

   E. "The project" includes all work in progress during the construction period.

   F. In describing the various items of equipment, in general, each item will be described singularly, even though there may be a multiplicity of identical or similar items.
G. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

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

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

J. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

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

L. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

M. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.5 GENERAL:

A. In general, the lines and ducts to be installed by the various trades under these specifications shall be run as indicated, as specified herein, as required by particular conditions at the site, and as required to conform to the generally accepted standards as to complete the work in a neat and satisfactorily workable manner. The following is a general outline concerning the running of various lines and ducts and is to be excepted where the drawings or conditions at the building necessitate deviating from these standards.

B. All piping and ductwork for the mechanical trade shall be concealed in chases in finished areas, except as indicated on the drawings. Horizontal lines run in areas that have ceilings shall be run concealed in those ceilings, unless otherwise specifically indicated or directed.

C. Piping and ductwork may be run exposed in machinery and equipment spaces, where serving as connections to equipment items in finished rooms where exposed connections are required, and elsewhere as indicated on the drawings or required.

D. The Contractor shall thoroughly acquaint himself with the details of the construction and finishes before submitting his bid as no allowances will be made because of the Contractor's unfamiliarity with these details. Place all inserts in masonry walls while they are under construction. All concealed lines shall be installed as required by the pace of the general construction to precede that general construction.

E. The mechanical plans do not give exact details as to elevations of lines and ducts, exact locations, etc., and do not show all the offsets, control lines, pilot lines and other installation details. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to provide proper grading of lines, to avoid all obstruction, to conform to details of installation supplied by
the manufacturers of the equipment to be installed, and thereby to provide an integrated, satisfactorily operating installation.

F. The mechanical plans do not give exact locations of outlets, fixtures, equipment items, etc. The exact location of each item shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with other sections. Minor relocations necessitated by the conditions at the site or as directed by the Architect shall be made without any additional cost accruing to the Owner.

G. The Contractor shall be responsible for the proper fitting of his material and apparatus into the space. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the drawings, he shall arrange for such space with the Architect before submitting his bid. Should changes become necessary on account of failure to comply with this clause, the Contractor shall make such necessary changes at his (the Contractor's) own expense.

H. The Contractor shall submit working scale drawings of all his apparatus and equipment which in any way varies from these specifications and plans. The drawings shall be checked by the Architect before the work is started. Any conflict with the building conditions shall be corrected by the Contractor before the work proceeds.

I. Order of precedence shall be observed in laying out the pipe, ductwork, material, and conduit in order to fit the material into the space above the ceiling and in the chases and walls. The following order shall govern:

1. Items affecting the visual appearance of the inside of the building such as lighting fixtures, diffusers, grilles, outlets, panelboards, etc. Coordinate all items to avoid conflicts at the site.
2. Lines requiring grade to function such as sewers.
3. Large ducts and pipes with critical clearances.
4. Conduit, water lines, and other lines whose routing is not critical and whose function would not be impaired by bends and offsets.

J. Piping and ducts serving outlets on items of equipment shall be run in the most appropriate manner. Where the equipment has built-in chases, the lines shall be contained therein. Where the equipment is of the open type, the lines shall be run as close as possible to the underside of the top and in a neat and inconspicuous manner.

K. Exceptions and inconsistencies in plans and specifications shall be brought to the Architect's attention before the contract is signed. Otherwise, the Contractor shall be responsible for any and all changes and additions that may be necessary to accommodate his particular apparatus, material, or equipment.

L. The Contractor shall distinctly understand that the work described herein and shown on the accompanying drawings shall result in a finished and working job, and any item required to accomplish this intent shall be included whether specifically mentioned or not.

M. Each bidder shall examine the plans and specifications for the General Construction. If these documents show any item requiring work under Division 23 and that work is not indicated on the respective "M" drawings, he shall notify the Architect in sufficient time to clarify before bidding. If no notification is received, the Contractor is assumed to require no clarification, and shall install the work as indicated on the General Plans in accordance with the specifications.

1.6 DIMENSIONS:

A. Before ordering any material or doing any work, the Contractor shall verify all dimensions, including elevations, and shall be responsible for the correctness of the same. No extra charge or compensation will be allowed on account of differences between actual dimensions and measurements indicated on
the drawings. Any difference which may be found shall be submitted to the Architect for consideration before proceeding with the work.

1.7 SUBMITTALS

A. Wherever shop drawings are called for in these specifications, they shall be furnished by the Contractor for the work involved after review by the Architect as to the make and type of material and in sufficient time so that no delay or changes will be caused. This is done in order to facilitate progress on the job and failure on the part of the Contractor to comply shall render him liable to stand the expense of any and all delays, changes in construction, etc., occasioned by his failure to provide the necessary details. Also, if the Contractor fails to comply with this provision, the Architect reserves the right to go directly to the manufacturer he selects and secure any details he might deem necessary and should there be any charges in connection with this, they shall be borne by the Contractor.

B. Shop drawings will be reviewed by the Architect for general compliance with the design concept of the project and general compliance with the information given in the contract documents. Review by the Architect and any action by the Architect in marking shop drawings is subject to the requirements of the entire contract documents. Contractor will be held responsible for quantities, dimensions which shall be confirmed and correlated at the job site, fabrication processes and techniques of construction, coordination of all trades and the satisfactory performance of his work.

C. Shop drawings submitted shall not consist of manufacturers' catalogues or tear sheets therefrom that contain no indication of the exact item offered. Rather, the submission of individual items shall designate the exact item offered and shall clearly identify the item with the project.

D. All shop drawings shall be submitted at one time and shall consist of a bound catalogue of all shop drawings under each section, properly indexed and certified that they have been checked by the Contractor.

E. The omissions of any material from the shop drawings which has been shown on the contract drawings or specified, even though reviewed by the Architect, shall not relieve the Contractor from furnishing and erecting same.

F. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.
   5. Material indicated in other Division 23 Sections.

G. Welding certificates.

1.8 QUALITY ASSURANCE

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

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
C. **Electrical Characteristics for HVAC Equipment:** Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.9 **PERMITS, FEE, ETC.:**

A. The Contractor under each section of these specifications shall arrange for a permit from the local authority. The Contractor shall arrange for all utility services, including sewer, water and gas services as applicable. If any charges are made by any of the utility companies due to the work on this project, the Contractor shall pay these charges, including charges for metering, connection, street cutting, etc. The Contractor shall pay for any inspection fees or other fees and charges required by ordinance, law, codes and these specifications.

1.10 **LAWS, CODES AND ORDINANCES:**

A. All work shall be executed in strict accordance with all local, state and national codes, ordinances and regulations governing the particular class of work involved, as interpreted by the inspecting authority. The Contractor shall be responsible for the final execution of the work under this heading to suit those requirements. Where these specifications and the accompanying drawings conflict with these requirements, the Contractor shall report the matter to the Architect, shall prepare any supplemental drawings required illustrating how the work may be installed so as to comply and, on approval, make the changes at no cost to the Owner. On completion of the various portions of the work the installation shall be tested by the constituted authorities, approved and, on completion of the work, the Contractor shall obtain and deliver to the Owner a final certificate of acceptance.

1.11 **DELIVERY, STORAGE, AND HANDLING**

A. Where stored outside provide pipes and tubes with end caps. Maintain end caps through storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

C. Refer to other Division 23 Sections for additional requirements.

1.12 **GUARANTEE:**

A. Unless a longer guarantee is hereinafter called for, all work, material and equipment items shall be guaranteed for a period of one year after acceptance by the Owner. All defects in labor and materials occurring during this period, as determined by the Architect, shall be repaired and/or replaced to the complete satisfaction of the Architect. Guarantee shall be in writing and in triplicate.

**PART 2 - PRODUCTS**

2.1 **MANUFACTURERS**

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
a. Where a definite material is mentioned in these specifications, it has been done in order to establish a standard. The product of the particular manufacturer mentioned is of satisfactory construction and any substitution must be of quality as good as or better than the named article. No substitution shall be made without review by the Architect, who will be the sole judge of equality.

b. Should a substitution be accepted under the provisions of the conditions of these specifications, and should this substitute prove to be defective or otherwise unsatisfactory for the service for which it is intended within the guarantee period, the Contractor who originally requested the substitution shall replace the substitute material with the specified material.

c. Refer to section 01 25 00 for substitution approval. Contractor shall pay for any and all A/E costs associated with a substitution requiring design modifications.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

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

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

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

2.5 ESCUTCHEONS

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

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

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

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

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 ACCESS PANELS:

A. Wherever mechanical and/or plumbing equipment is installed and where future access is required through either walls or ceilings and such cannot be obtained through the removable ceiling or through other means, the Contractor shall provide Milcor Style "M" access doors at least 24 inches by 24 inches in size or larger if required for access. Provide access doors for all fire dampers, smoke dampers, valves, etc. Provide rated access panels as required for installation in rated construction.

3.2 USE OF SYSTEMS:

A. Except for operation of cooling equipment to prove its performance and to adjust and balance the systems, that equipment will not be operated for comfort of construction workers.

B. Immediately prior to the time that the systems are to be accepted by the Owner, each system shall be carefully examined and if ductwork is dirty, it shall be carefully cleaned by men skilled in that type of work. All filters shall be put in first class condition by replacement of filters and/or other procedures as directed.

C. The use of the equipment for maintaining environmental and/or protective temperature conditions shall in no way constitute acceptance of that equipment and the connected piping, ducts, insulation, finishes, etc. by the Owner. Furthermore, it shall in no way shorten the guarantee period hereinafter specified. The Contractor shall either secure extended warranties from the vendors of equipment or shall purchase insurance to provide proper coverage on the equipment through the guarantee period and shall file with the Architect substantiating affidavits from equipment manufacturers or a copy of the insurance policy covering the equipment through the guarantee period. The personal underwriting of the Contractor for equipment manufacturers' warranties is not acceptable, but his personal underwriting of piping, ductwork, insulation and associated materials is acceptable subject to the provisions of the contract.
D. The Contractor shall provide such labor as may be required in the operation of the systems and shall pay all costs.

3.3 SCHEDULE OF WORK:

A. The work under the various sections must be expedited and close coordination will be required in executing the work. The various trades shall perform their portion of the work at such times as directed so as to insure meeting scheduled completion dates, and to avoid delaying any other trade. The Architect will set up completion dates, schedule the times of work in the various areas involved, etc. Each Contractor shall cooperate in establishing these times and locations and shall process his work so as to insure the proper execution of it.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation. This shall include space between adjacent pipes or crossing pipes.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas, plumbing chases, or other wet areas 2 inches above finished floor level.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
      b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
         1) Seal space outside of sleeve fittings with grout.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

N. Fire-BARRIER Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

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

3.5 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.


3.6 ELECTRICAL WIRING:

A. All electric wiring of every character, except for temperature control, shall be done under Division 26 of these specifications. The Contractor for each section shall erect all his motors in place ready for connections. The Contractor, under Division 26, shall mount all the starters and controls, furnishing the supporting structures and any required outlet boxes.
B. Every electrical current consuming device furnished as a part of this project, or furnished by the Owner and installed in this project, shall be completely wired up under Division 26. Verification of exact location, method of connection, number and size of wires required, voltage requirements, and phase requirements is the responsibility of the Contractor under Division 26. If conflicts occur between the drawings and the actual requirements, actual requirements shall govern.

3.7 SEALING AROUND PIPES, DUCTS, ETC.:

A. The Contractor installing pipes, ducts, etc. shall seal all spaces between pipes and/or sleeves where they pierce walls, partitions or floors with Johns-Manville Firetemp CI intumescent caulk or as directed by architect. The packing shall effect a complete fire and/or air seal where pipes, ducts, etc., pierce walls, floors or partitions.

3.8 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

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

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

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

E. Rough-In and Final Connection for Equipment:
   1. The shop drawings for all equipment are hereby made a part of these specifications. The Contractor under each section of the specifications shall rough-in for the exact item to be furnished on the job, whether in another section of the specifications or by the Owner. The Contractor shall refer to all drawings and other sections of the specifications for the scope of work involved for the new equipment, and by actual site examination determine the scope of the required equipment connections for the Owner furnished equipment.
   2. Should any of the equipment furnished require connections of a nature different from that shown on the drawings, report the matter to the Architect and finally connect as directed by the Architect.
   3. Should any shop drawings not be available for equipment furnished under other contracts or by the Owner, the Contractor under each section of these specifications shall bid the work as detailed on the drawings.
   4. Minor differences in the equipment furnished and that indicated on the drawings will not constitute ground for additional payment to the Contractor.

3.9 PROGRESS OF WORK:

A. The Contractor shall keep himself fully informed as to the progress of the work and do his work at the proper time without waiting for notification from the Architect or Owner.

3.10 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

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

3.11 MANUFACTURER'S DIRECTIONS:

A. All manufactured articles shall be applied, installed and handled as recommended by the manufacturer.

3.12 MATERIALS AND WORKMANSHIP:

A. All materials shall be new unless otherwise specified and of the quality specified. Materials shall be free from defects. All materials of a type for which the Underwriters Laboratories, Inc. have established a standard shall be listed by the Underwriters Laboratories, Inc. and shall bear their label.

B. Wherever the make of material or apparatus required is not definitely specified, the Contractor shall submit a sample to the Architect before proceeding.

C. The Architect reserves the right to call for samples of any item of material offered in substitution, together with a sample of the specified material, when, in the Architect's opinion, the quality of the material and/or the appearance is involved and it is deemed that an evaluation of the two materials may be better made by visual inspection. This shall be limited to plumbing brass, grilles, registers, ceiling outlets and similar items and shall not be applicable to major manufacturers' items of equipment.

D. The Contractor shall be responsible for transportation of his materials to and on the job, and shall be responsible for the storage and protection of these materials and work until the final acceptance of the job.

E. The Contractor shall furnish all necessary scaffolding, tackle, tools and appurtenances of all kinds, and all labor required for the safe and expeditious execution of his contract.

F. The workmanship shall in all respects be of the highest grade and all construction shall be done according to the best practice of the trade.

3.13 LARGE APPARATUS:

A. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through windows, doorways or shafts, shall be brought to the job by the Contractor involved and placed in the space before the enclosing structure is completed.

3.14 PREPARED OPENINGS:

A. It is anticipated that an opening will be required in the existing building for installation of the large equipment. Cooperate with all trades to avoid a larger opening than is required. The openings shall be restored after installation of the equipment.

3.15 PROTECTION OF APPARATUS:

A. The Contractor shall at all times take such precautions as may be necessary to properly protect his new apparatus from damage. This shall include the erection of all required temporary shelters to adequately protect any apparatus stored in the open on the site, the cribbing of any apparatus above the floor of the
construction, and the covering of apparatus in the uncompleted building with tarpaulins or other protective covering. Failure on the part of the Contractor to comply with the above to the entire satisfaction of the Architect will be sufficient cause for the rejection of the pieces of apparatus in question.

3.16 COOPERATION AND CLEANING UP:

A. The contractor for the work under each section of these specifications shall coordinate his work with the work described in all other sections of the specifications to the end that, as a whole, the job shall be a finished one of its kind, and shall carry on his work in such a manner that none of the work under any section of these specifications shall be handicapped, hindered or delayed at any time.

B. At all times during the progress of the work, the Contractor shall keep the premises clean and free of unnecessary materials and debris. The Contractor shall, on direction at any time from the Architect, clear any designated areas or area of materials and debris. On completion of any portion of the work, the Contractor shall remove from the premises all tools and machinery and all debris occasioned by the work, leaving the premises free of all obstructions and hindrances.

3.17 COORDINATION OF TRADES:

A. The Contractor shall be responsible for resolving all coordination required between trades. For example, items furnished under Division 23 which require electrical connections shall be coordinated with Division 26 for:
   1. Voltage
   2. Phase
   3. Ampacity
   4. No. and size of wires
   5. Wiring diagrams
   6. Starter size, details and location
   7. Control devices and details

B. Items furnished under various sections which require plumbing connections shall be coordinated for services, pressure, size and location of connections, type of fuel, clearances for service, auxiliary devices required, etc.

C. Items requiring insulation shall be fully insulated and that insulation shall be checked against manufacturer’s directions and job requirements for suitability, coverage, thickness and finish.

D. Items installed in/on finished ceilings shall be coordinated with the ceiling construction. The Contractor under each section shall conform to the reflected ceiling plan and shall secure details and/or samples of the ceiling materials as necessary to insure compatibility. Any device not conforming to this requirement shall be replaced by the Contractor at his expense.

E. All items specified under Division 23 shall be installed tight, plumb, level, square and symmetrically placed in relation to the work of other trades.

3.18 TESTING:

A. The Contractor under each division shall at his own expense perform the various tests as specified and required by the Architect and as required by the State and local authorities. The Contractor shall furnish all fuel and materials necessary for making tests. Notify the Architect a minimum of 24 hours in advance of all tests.
3.19 PAINTING

A. All painting shall be done by the Contractor under Division 09. Following is a general outline of the required work for Division 23.

1. When the factory finish on any apparatus or equipment is marred, it shall be touched up and then given one coat of half flat half enamel, followed by a coat of machinery enamel of a color to match the original. Paint factory primed surfaces.
2. Paint all exposed pipe, cabinets, hangers and supports and miscellaneous metal.
3. Paint all exposed sheet metal.
4. Paint all insulated surfaces exposed to view, including piping, equipment, etc. Size surfaces until a smooth, non grainy surface is obtained.
5. Generally, painting is required on all surfaces such that no exposed bare metal or insulation surface is visible.
6. Paint all surfaces above or behind perforated return air grilles or other open spaced air outlet devices with flat black paint. All pipes, conduits, ductwork and structural members shall be painted. These surfaces shall be painted a distance away from the grille such that no unpainted surfaces are visible to a person standing on the room side and viewing through the device.

3.20 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section.

3.21 ERECTION OF METAL SUPPORTS AND ANCHORAGE

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

B. Field Welding: Comply with AWS D1.1.

3.22 GROUTING

1. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
2. Clean surfaces that will come into contact with grout.
3. Provide forms as required for placement of grout.
4. Avoid air entrapment during placement of grout.
5. Place grout, completely filling equipment bases.
6. Place grout on concrete bases and provide smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout.
3.23 INSTALLATION DRAWINGS:

A. It shall be incumbent upon the Contractor to prepare special drawings as called for elsewhere herein or as directed by the Architect to coordinate the work under each section, to illustrate changes in his work, to facilitate its concealment in finished spaces to avoid obstructions or to illustrate the adaptability of any item of equipment which he proposes to use.

B. These drawings shall be used in the field for the actual installation of the work. Unless otherwise directed, they shall not be submitted for approval but three copies shall be provided to the Architect for his information.

3.24 OPERATING INSTRUCTIONS:

A. The Contractor for each section of the work hereunder shall, in cooperation with the representatives of the manufacturers of the various equipment items, carefully instruct the Owner's representatives in the proper operation of each item of equipment and of each system. During the balancing and adjusting of systems, the Owner's representative shall be made familiar with all procedures.

B. The contractor shall coordinate the date and time for the training with the Owner's representative and shall document attendance with a sign-in sheet. At a minimum, the sign-in sheet shall indicate the date and location of the session, name and organization of each participant, and a list of any material that may be provided. This information shall be provided to the Architect as part of the closeout documents. Failure to provide documentation of training may require the contractor to provide a subsequent training session.

3.25 OPERATING MANUALS:

A. Prepare and submit 3 copies of the operating manuals bound in hard covers. Three weeks prior to completion of the work, the Architect will check the manuals and any additional material necessary to complete the manuals shall be furnished and inserted by the Contractor.

B. Manuals shall contain the following data:
   1. Catalogue data of all equipment.
   2. Shop drawings of all equipment.
   3. Temperature control drawings (reduced in size)
   4. Start-up instructions for major equipment.
   5. Trouble shooting procedures for major equipment.
   6. Wiring diagrams.
   7. Recommended maintenance schedule for equipment.
   8. Parts list for all items.
   9. Name and address of each vendor.

3.26 COMPLETION REQUIREMENTS:

A. Before acceptance and final payment the Contractor under each Division of the specifications shall furnish:
   1. Accurate record drawings, shown in red ink on blue line prints furnished for that purpose all changes from the original plans made during installation of the work. Drawings shall be filed with the Architect when the work is completed.
   2. All manufacturers' guarantees.
   3. All operating manuals.
5. Test and Balance Report.

3.27 CONTRACTOR'S RESPONSIBILITY FOR FINAL INSPECTION:

1. Before calling for the final inspection, the Contractor under each Division shall carefully inspect his work to be sure it is complete and according to plans and specifications.

END OF SECTION 23 05 00
SECTION 23 05 13 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

A. RELATED DOCUMENTS

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

C. SUMMARY

D. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

E. COORDINATION

F. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

A. GENERAL MOTOR REQUIREMENTS

B. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

C. Comply with NEMA MG 1 unless otherwise indicated.

D. MOTOR CHARACTERISTICS

E. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

F. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

G. POLYPHASE MOTORS

H. Description: NEMA MG 1, Design B, medium induction motor.

I. Efficiency: Premium efficient, as defined in NEMA MG 1.

J. Service Factor: 1.15.

K. Multispeed Motors: Separate winding for each speed.
L. Rotor: Random-wound, squirrel cage.
M. Bearings: Re-greaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.
N. Temperature Rise: Match insulation rating.
O. Insulation: Class F unless otherwise indicated.

P. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

Q. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

R. POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS
S. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

T. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Provide all motors operating with a VFD with a shaft grounding ring equal to Aegis SGR.

U. SINGLE-PHASE MOTORS
V. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Split phase for motors smaller than 1/6 hp.
   2. Capacitor start, capacitor run for motors 1/6 hp and larger.

W. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
X. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

Y. Motors 1/20 HP and Smaller: Shaded-pole type.

Z. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Thermometers.
   2. Thermowells.
   4. Test plugs.
   5. Turbine flowmeters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Ashcroft Inc.
   2. Marsh Bellofram.
   4. Trerice, H. O. Co.
   5. Weiss Instruments, Inc.
   6. Winters Instruments - U.S.


C. Case: Sealed- type(s); stainless steel with 5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C. Select scale ranges for maximum readability at the design temperature of the medium being measured.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass or plastic.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ernst Flow Industries.
      b. Marsh Bellofram.
      c. Miljoco Corporation.
      e. REOTEMP Instrument Corporation.
      f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
      g. Weiss Instruments, Inc.
      h. WIKA Instrument Corporation - USA.
   3. Case: Plastic; 9-inch nominal size unless otherwise indicated.
   4. Case Form: Adjustable angle unless otherwise indicated.
   5. Tube: Glass with magnifying lens and blue or red organic liquid.
   6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
   7. Window: Glass or plastic.
   8. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.
   10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Material for Use with Steel Piping: CRES.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
   10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AMETEK, Inc.; U.S. Gauge.
      b. Marsh Bellofram.
      c. Trerice, H. O. Co.
      d. Weiss Instruments, Inc.
      e. Winters Instruments - U.S.
   3. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa. Furnish each gauge with scale range suitable for the duty. Upper range of scale shall be minimum two times greater than expected pressure.
   9. Window: Glass or plastic.
   10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Siphons: Loop-shaped section of brass pipe with NPS 1/4 pipe threads.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.6 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flow Design, Inc.
   2. Trerice, H. O. Co.
   3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   4. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.
2.7 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Trerice, H. O. Co.
   2. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   3. Weiss Instruments, Inc.

B. Furnish one test-plug kits containing two thermometers, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

2.8 FLOWMETERS

A. Turbine Flowmeters:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ONICON Incorporated.
   2. Description: Flowmeter with sensor and indicator.
   3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   4. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute.
      a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water.
      b. Construction: Stainless-steel body, with plastic turbine or impeller.
      d. Minimum Temperature Rating: 180 deg F.
   5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
   6. Accuracy: Plus or minus 2 percent.
   7. Display: Shows rate of flow.
   8. Operating Instructions: Include complete instructions with each flowmeter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install valve in piping for each pressure gage for fluids (except steam).

I. Install valve and syphon fitting in piping for each pressure gage for steam.

J. Install test plugs in piping tees.

K. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

L. Install flowmeter elements in accessible positions in piping systems.

M. Install flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

N. Install permanent indicators on walls or brackets in accessible and readable positions.

O. Install connection fittings in accessible locations for attachment to portable indicators.

P. Install thermometers at locations indicated on the drawings, and in the following locations:
   1. Inlet and outlet of each hydronic boiler.
   2. Inlets and outlets of each chiller.
   3. Inlet and outlet of each hydronic coil in air-handling units.
   4. Two inlets and two outlets of each hydronic heat exchanger.
   5. Supply and return piping at the point of entry into the building from a remote location, such as a central plant.

Q. Install pressure gages at locations indicated on the drawings, and in the following locations:
   1. Discharge of each pressure-reducing valve.
   2. Suction and discharge of each pump.
   3. Supply and return piping at the point of entry into the building from a remote location, such as a central plant.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.
3.3 ADJUSTING
A. After installation, calibrate meters according to manufacturer's written instructions.
B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 FLOWMETER SCHEDULE
A. Flowmeters for Chilled-Water Piping: Turbine type.

END OF SECTION 23 05 19
SECTION 23 05 29  HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.
      c. Flex-Strut Inc.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut Corporation; Tyco International, Ltd.
      g. Wesanco, Inc.
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

B. Non-MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Anvil International; a subsidiary of Mueller Water Products Inc.
b. Empire Industries, Inc.
c. ERICO International Corporation.
d. Haydon Corporation; H-Strut Division.
e. NIBCO INC.
f. PHD Manufacturing, Inc.
g. PHS Industries, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.


4. Channels: Continuous slotted steel channel with inturned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.


2.4 THERMAL-HANGER SHIELD INSERTS

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

1. Carpenter & Paterson, Inc.
2. ERICO International Corporation.
4. PHS Industries, Inc.
5. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
6. Rilco Manufacturing Co., Inc.
7. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:
   1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   2. Bases: One or more; plastic.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.
   5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

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

B. Grout: Refer to Section 23 05 00.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.

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


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

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

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

3.2 EQUIPMENT SUPPORTS

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

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

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

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

3.6 HANGER AND SUPPORT SCHEDULE

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

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.

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

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

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

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

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

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

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

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

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

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

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

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

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

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

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

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

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

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

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

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

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

6. C-Clamps (MSS Type 23): For structural shapes.

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

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

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

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
   6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
   7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
   8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. Horizontal (MSS Type 54): Mounted horizontally.
      b. Vertical (MSS Type 55): Mounted vertically.
      c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29
SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.

1.3 ACTION SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   6. Minimum Letter Size: 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number along with area served, where listed on equipment schedule.
2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. Color scheme shall comply with ANSI A13.1.

B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.3 MBD FLAGS

A. Material: Fluorescent yellow 1-3/16" wide plastic flagging tape

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   2. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   3. At access doors, manholes, and similar access points that permit view of concealed piping.
   4. Near major equipment items and other points of origination and termination.
   5. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   6. On piping above removable acoustical ceilings.

3.4 DUCT MBD FLAG INSTALLATION

A. Install plastic flags at each manual balancing damper to hang a minimum of 12" below bottom of the duct.

END OF SECTION 23 05 53
SECTION 23 05 93  TESTING, ADJUSTING, AND BALANCING

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. This Section includes TAB to produce design objectives for the following:

1. HVAC air systems.
2. HVAC equipment quantitative-performance settings.
   a. Existing systems TAB.
   b. Verifying that automatic control devices are functioning properly.
   c. Reporting results of activities and procedures specified in this Section.

3. The testing, balancing and adjusting of all HVAC equipment and systems will be performed by an independent Testing and Balancing (TAB) Agency, retained and paid by the District. The Testing and Balancing Company shall be pre-qualified by the A/E with PIUSD during Project Design. The TAB Agency shall be experienced, possessing calibrated instruments, qualified Engineers (at least one of whom must be a Registered Professional Engineer), and technicians to perform the required tests. Three sets of the final balancing operation shall be periodically observed and approved by the project Consulting Engineer. The final balancing report shall be provided to the District.

4. The TAB Agency shall be brought in early during the construction phase to review all contract drawings and specifications, addenda, equipment and control submittals and shop drawings, etc., and to offer any input on equipment, system and control installation and operation as may impact his testing, balancing and commissioning services.

5. The TAB Agency will be required to perform on-site review of all HVAC and control installations prior to testing and balancing procedures, and will develop and submit interim reports identifying all installation and functional deficiencies found that would in any way impact testing, balancing and commissioning services. All deficiencies will be corrected by the Contractors prior to conducting testing, balancing and commissioning activities.

6. General contractor and all sub-contractors shall provide support to test and balance activities through preparation and adjustment of systems and correction of all deficiencies. All systems shall be prepared for the TAB as noted below. The controls contractor shall be available to establish setpoints and provide the TAB contractor with access to the BAS.

7. The TAB Agency will be required to perform a complete commissioning of the control and operation of all new construction and upgraded HVAC equipment and systems. Commissioning shall include verification and report of all control sequences, monitoring points, set points, and measured conditions (temperature, humidity, flows, etc.). Commissioning shall be included in the final balancing report submitted.

1.3 SCOPE SUMMARY

A. The basic project TAB scope shall include the following objectives:

1. Provide a complete TAB on the renovated fine arts areas of Cele MS, Dessau MS, Kelly Lane MS, Park Crest MS, Pflugerville MS, Westview MS, Connally HS, and Hendrickson HS including the new and existing mechanical equipment (exhaust fans and associated RTU's and air handlers), new and existing supply diffusers, exhaust and return grilles.
1.4 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. RC: Room criteria.

F. Report Forms: Test data sheets for recording test data in logical order.

G. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

H. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

I. TAB: Testing, adjusting, and balancing.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of systems or equipment.

L. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.5 SUBMITTALS

A. Qualification Data: Submit evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB Reports: Submit three copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

1.6 QUALITY ASSURANCE

A. TAB Firm Qualifications: The TAB Agency will be required to be certified by the Associated Air Balance Council (AABC). NEBB certification only is not considered adequate. Acceptable Testing & Balancing Agencies will be prequalified and submitted by general contractor for Architect/Engineer and District approval.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
C. Agenda Items: Include at least the following:
   1. Submittal distribution requirements.
   3. TAB plan.
   4. Work schedule and Project-site access requirements.
   5. Coordination and cooperation of trades and subcontractors.
   6. Coordination of documentation and communication flow.

D. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


F. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification".

G. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.7 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine equipment performance data including fan curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

F. Examine system and equipment test reports.

G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

I. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

K. Examine two-way valves for proper installation for their intended function of diverting or mixing fluid flows.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine equipment for installation and for properly operating safety interlocks and controls.

N. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Automatic temperature-control systems are operational.
   2. Equipment and duct access doors are securely closed.
   3. Balance, smoke, and fire dampers are open.
   4. Isolating and balancing valves are open and control valves are operational.
   5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.
J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
      e. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   2. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
      a. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
      b. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
      c. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

C. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   1. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

3.6 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer, model, and serial numbers.
   4. Efficiency rating.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.7 PROCEDURES FOR HEAT-TRANSFER COILS

A. Refrigerant Coils: Measure the following data for each coil:
   1. Refrigerant suction pressure and temperature.
   2. Dry-bulb temperature of entering and leaving air.
   3. Wet-bulb temperature of entering and leaving air.
   4. Airflow.
   5. Air pressure drop.

3.8 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.9 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.10 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note the speed of response to input changes.

G. Check the interaction of interlock and lockout systems.

H. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or non-grounded power supply.
I. Note operation of electric actuators using spring return for proper fail-safe operations.

3.11 TOLERANCES

A. Set HVAC system airflow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Minus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.

3.12 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in “Examination” Article, prepare a report on the adequacy of design for systems’ balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:
   1. Fan curves.
   2. Manufacturers’ test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer’s name and address.
   7. Contractor's name and address.
   9. Signature of TAB firm who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
   13. Notable characteristics of systems.
14. Description of system operation sequence if it varies from the Contract Documents.
15. Nomenclature sheets for each item of equipment.
16. Data for terminal units, including manufacturer, type size, and fittings.
17. Notes to explain why certain final data in the body of reports varies from indicated values.
18. Test conditions for fans performance forms including the following:
   a. Settings for outside-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Fan drive settings including settings and percentage of maximum pitch diameter.
   e. Settings for supply-air, static-pressure controller.
   f. Other system operating conditions that affect performance.

E. Roof Top Unit Test Reports: For packaged DX air-handling units with gas-fired furnaces, include the following:

1. Unit Data: Include the following:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches, and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm (L/s).
   b. Total system static pressure in inches wg (Pa).
   c. Fan rpm.
   d. Discharge static pressure in inches wg (Pa).
   e. Filter static-pressure differential in inches wg (Pa).
   f. Cooling coil static-pressure differential in inches wg (Pa).
   g. Outside airflow in cfm (L/s).
   h. Return airflow in cfm (L/s).
   i. Outside-air damper position.
   j. Return-air damper position.

4. Apparatus-Coil Test Reports:
   a. Unit Data:
   b. System and air-handling unit identification.
   c. Location and zone.
   d. Room served.
   e. Coil make and size.
   f. Refrigerant expansion valve and refrigerant type.
   g. Test Data (Indicated and Actual Values):
   h. Airflow rate in cfm (L/s).
i. Average face velocity in fpm.

j. Air pressure drop in inches wg.

k. Outdoor-air, wet- and dry-bulb temperatures in deg F.

l. Return-air, wet- and dry-bulb temperatures in deg F.

m. Entering-air, wet- and dry-bulb temperature in deg F.

n. Leaving-air, wet-and dry-bulb temperature in deg F.

o. Unit discharge dry-bulb temperature in cooling and dehumidification mode in deg F.

5. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   a. Fan Data:
      1) System identification.
      2) Location.
      3) Make and type.
      4) Model number and size.
      5) Manufacturer's serial number.
      6) Arrangement and class.
      7) Sheave make, size in inches (mm), and bore.
      8) Sheave dimensions, center-to-center, and amount of adjustments in inches.
   b. Motor Data:
      1) Make and frame type and size.
      2) Horsepower and rpm.
      3) Volts, phase, and hertz.
      4) Full-load amperage and service factor.
      5) Sheave make, size in inches (mm), and bore.
      6) Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
      7) Number of belts, make, and size.

6. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm (L/s).
   b. Total system static pressure in inches wg (Pa).
   c. Fan rpm.
   d. Discharge static pressure in inches wg (Pa).
   e. Suction static pressure in inches wg.

F. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F (deg C).
   d. Duct static pressure in inches wg (Pa).
   e. Duct size in inches (mm).
   f. Duct area in sq. ft. (sq. m).
   g. Indicated airflow rate in cfm (L/s).
   h. Indicated velocity in fpm (m/s).
   i. Actual airflow rate in cfm (L/s).
   j. Actual average velocity in fpm (m/s).
   k. Barometric pressure in psig.

G. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
3.14 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check
      measurements to verify that the system is operating according to the final test and balance
      readings documented in the Final Report.
   2. Randomly check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
   3. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the
      set point.
   4. Verify that balancing devices are marked with final balance position.

B. Final Inspection:
   1. After initial inspection is complete and evidence by random checks verifies that testing and
      balancing are complete and accurately documented in the final report, request that a final
      inspection be made by Architect.
   2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner and
      Architect.
   3. Architect shall randomly select measurements documented in the final report to be rechecked.
      The rechecking shall be limited to either 10 percent of the total measurements recorded, or the
      extent of measurements that can be accomplished in a normal 8-hour business day.
   4. If the rechecks yield measurements that differ from the measurements documented in the final
      report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements
      checked during the final inspection, the testing and balancing shall be considered incomplete and
      shall be rejected.
   6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and
      balancing device settings to include all changes and resubmit the final report.
   7. Request a second final inspection. If the second final inspection also fails, Owner shall contract
      the services of another TAB firm to complete the testing and balancing in accordance with the
      Contract Documents and deduct the cost of the services from the final payment.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced
   conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter
   conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter
   conditions.

END OF SECTION 23 05 93
SECTION 23 07 13  DUCT INSULATION

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes insulating the following duct services:
   1. Indoor, concealed supply, return, and outdoor air.

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

B. Submittals shall provide documentation that products contain no added formaldehyde and that all adhesives, mastics, and sealants meet the most current VOC limits of SCAQMD r1168 and r113.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION
A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING
A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS
A. Products shall not contain added-urea-formaldehyde, asbestos, lead, mercury, or mercury compounds.
B. All adhesives, mastics, and sealants shall be required to meet the most current VOC limits of SCAQMD r1168.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite XG.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed Corp.; Commercial Board.
      b. Johns Manville; 800 Series Spin-Glas.
      c. Knauf Insulation; Insulation Board.
      d. Owens Corning; Fiberglas 700 Series.

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed Corp.; CrimpWrap.
      b. Johns Manville; MicroFlex.
      c. Knauf Insulation; Pipe and Tank Insulation.
      d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Eagle Bridges - Marathon Industries; 225.

   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Eagle Bridges - Marathon Industries; 225.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      b. Eagle Bridges - Marathon Industries; 570.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering ducts.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Vimasco Corporation; Elastafab 894.

2.7 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
2.8 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.

2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter Shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CHP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter Shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2) GEMCO; Peel & Press.
      3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter Shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.

5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
2.10 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

   1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistant joint sealers.

E. Insulation Installation at Floor Penetrations:

   1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions larger than 22 inches, place pins 18 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   b. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   c. Do not overcompress insulation during installation.
   d. Impale insulation over pins and attach speed washers.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
2. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.8 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Painting shall be done by the Division 9 Contractor. Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.
3.9 FIELD QUALITY CONTROL

A. The installation of all thermal insulation shall be performed by a recognized firm regularly engaged in the insulation business, using skilled insulation mechanics and using insulation materials which are the product of reputable manufacturer of the materials, using any special materials as required by these specifications and by those published standards.

B. Any insulation which is not applied in a workmanlike manner will be rejected and replaced. All coverings shall be smooth, flush, dressed to line and tight. Mastic shall be neatly applied and tooled. The Architect reserves the right to reject any insulation whose appearance he deems unacceptable.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply, return and outdoor air.
2. Indoor, back of ceiling diffusers

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, supply, return and outside-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density when installed in conditioned area or return air plenum. Insulation shall be 3 inches thick in unconditioned space or attic.
2. Existing duct that is internally insulated shall not require exterior wrap insulation. Provide metal nose-guard around duct liner at duct connections to prohibit exposure of fibers to airstream.

END OF SECTION 23 07 13
SECTION 23 08 00

COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:

1. Cooling generation systems, including direct-expansion systems
2. Distribution systems, including air distribution (heating and cooling) systems, hot-water distribution systems, exhaust systems.
3. Terminal and packaged units
4. Controls and instrumentation, including BAS
5. Systems testing and balancing verification, including heating-water piping systems, domestic hot-water circulating systems, supply-air systems, return-air systems, exhaust-air systems.

B. The TAB Agency will be required to perform a complete commissioning of the control and operation of all new construction and upgraded HVAC equipment and systems. Commissioning shall include verification and report of all control sequences, monitoring points, set points, and measured conditions (temperature, humidity, flows, etc.). Commissioning shall be included in the final balancing report submitted.

1.3 DEFINITIONS

A. BAS: Building automation system.
B. DDC: Direct digital controls.
D. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
E. TAB: Testing, adjusting, and balancing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.
B. Construction Checklists: See related Sections for technical requirements for the following construction checklists:

1. Vibration and seismic controls for HVAC&R piping and equipment.
2. Instrumentation and control for HVAC&R.
3. Heating-water piping and accessories.
4. Refrigerant piping.
5. Metal ducts and accessories.
6. Fans.
7. Particulate air filtration.
8. Air-handling units.

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
   1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
   2. Minimum three years experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
   1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
   2. Minimum three years experience installing, servicing, and operating systems manufactured by approved manufacturer.
   3. Associated Air Balance Council (AABC) Certified Test and Balance Technician.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:
   1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
      a. Equipment/instrument identification number.
      b. Planned commissioning application or use.
      c. Manufacturer, make, model, and serial number.
      d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
   2. Test equipment and instrumentation shall meet the following criteria:
      a. Capable of testing and measuring performance within the specified acceptance criteria.
      b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
      c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
      d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:
   1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:
      a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:
1) Instrument or tool identification number.
2) Equipment schedule designation of equipment for which the instrument or tool is required.
3) Manufacturer, make, model, and serial number.
4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.

c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

F. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

G. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.

   1. Contributors to the development of construction checklists shall include, but are not limited to, the following:
      a. HVAC&R systems and equipment installers.
      b. TAB technicians.
      c. HVAC&R instrumentation and controls installers.

H. Perform tests using design conditions, whenever possible.

   1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

J. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

K. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.

L. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.

M. Provide technicians, instrumentation, tools, and equipment to complete and document the following:
   1. Performance tests.
   2. Demonstration of a sample of performance tests.
   3. Commissioning tests.

3.2 TAB COMMISSIONING TESTS

A. TAB Verification:
   1. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   2. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
   3. Scope: HVAC&R air systems and hydronic piping systems.
   4. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.
   5. Conditions of the Test:
      a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
      b. Systems operating in full heating mode with minimum outside-air volume.
      c. Systems operating in full cooling mode with minimum outside-air volume.
      d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.
   6. Acceptance Criteria:
      a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
      b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
      c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.
3.3 HEATING CONTROL SYSTEM COMMISSIONING TESTS

A. General
1. The following paragraphs outline the functional test procedures for the various Div. 23 items to be commissioned.
2. All systems controlled via the Building Automation System shall have all control points and sequences tested by Controls Contractor prior to requesting testing by Commissioning Authority.

B. All Equipment:
1. Verify nameplate information (serial numbers, model numbers, etc.); verify that equipment capacity is in accordance with requirements of construction documents.
2. Verify unit runs smoothly and quietly.
3. Verify operation of safeties.
4. Verify electrical wiring and grounding is correct.
5. Verify maintenance and NEC clearances are maintained.

C. Dx Single-Zone Units:
1. Record outside air temperature during test.
2. Record space temperature during test.
3. Record programmed setpoints (occ/unocc heating and cooling temps, runtime, safeties and alarms)
4. Record programmed schedules and interlocks
5. Verify fans run smoothly and quietly.
6. Verify voltages and amperages are within tolerance.
8. Verify compressor cycling to control space temperature.
9. Verify Smoke detector operation.
10. Verify all alarms and safeties.
11. Verify all sequences.

D. Heating-Water Supply Temperature Control:
1. Prerequisites: Installation verification of the following:
   a. Startup of boiler
   b. Startup of heating-water pump(s)
   c. TAB of heating-water flow and pressure.
   d. Input Device: Heating-water supply temperature; thermostat
   e. Output Device: Control valve
   f. Display the following at the operator's workstation:
      1) Heating-water supply temperature.
      2) Heating-water supply temperature set point.
      3) Control-valve position.
2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at input device
4. Conditions of the Test:
   a. Minimum heating-water flow.
   b. Midrange Heating-Water Flow: [50 to 60] <Insert number(s)> percent of maximum.
   c. Maximum heating-water flow.
5. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.
3.4 TERMINAL UNIT EQUIPMENT COMMISSIONING TESTS

A. Variable-Air-Volume Terminal Air Units with Coils:
   1. Prerequisites: Installation verification of the following:
      a. Occupancy Input Device: Occupancy sensor.
      b. Occupancy Output Device: DDC system binary output.
      c. Room Temperature Input Device: Electronic temperature sensor.
      d. Room Temperature Output Device: Electronic damper actuators and control-valve operators.
      e. Display the following at the operator's workstation:
         1) Room/area served.
         2) Room occupied/unoccupied.
         3) Room temperature indication.
         4) Room temperature set point.
         5) Room temperature set point, occupied.
         6) Room temperature set point, unoccupied.
         7) Air-damper position as percentage open.
         8) Control-valve position as percentage open.

   2. Scope: Variable-air-volume terminal air units with hydronic coils in supply-air systems, and associated controls.
   3. Purpose:
      a. Occupancy-dependent room temperature set-point reset.
      b. Room temperature control.
   4. Conditions of the Test:
      a. Commissioning Test Demonstration Sampling Rate: 10 percent of each model/size unit.
      b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe temperature control until room temperature is stable at occupied set point plus or minus 1.0 deg F.
      c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until room temperature is stable at unoccupied set point plus or minus 1.0 deg F.
   5. Acceptance Criteria:
      a. Temperature Control - Occupied:
         1) Control system status changes from "occupied" to "unoccupied" after the specified time.
         2) Room temperature is stable at occupied set point plus or minus 1.0 deg within 10 minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than 2.0 deg F during transition.
      b. Temperature Control - Unoccupied:
         1) Control system status changes from "unoccupied" to "occupied" after five minutes of continuous occupancy.
         2) Room temperature is stable at unoccupied set point plus or minus 1.0 deg within 30 minutes of occupancy.

END OF SECTION 230800
SECTION 23 09 00  BUILDING AUTOMATION SYSTEMS (BAS)

PART 1 -GENERAL

1.1  SCOPE:

A. Provide and install a native BACnet-based Direct Digital Control system in accordance with this specification. All building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by the latest version of ANSI/ASHRAE Standard 135, BACnet. All new controllers, including unitary controllers, shall be native BACnet devices. Gateways may only be used for communication to existing systems or where specified in the project documents.

B. Integrate all new controls into the existing BAS installed at each campus. Integration shall include graphics on the GUI with all new I/O points including soft switches, overrides, and schedules as required by the construction documents. The current manufacturer of the campus BAS systems is as indicated below:

<table>
<thead>
<tr>
<th>Campus</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connally HS</td>
<td>Alerton</td>
</tr>
<tr>
<td>Dessau MS</td>
<td>Alerton</td>
</tr>
<tr>
<td>Hendrickson HS</td>
<td>Novar</td>
</tr>
<tr>
<td>Kelly Lane MS</td>
<td>Novar</td>
</tr>
<tr>
<td>Park Crest MS</td>
<td>Alerton</td>
</tr>
<tr>
<td>Pflugerville HS</td>
<td>Alerton</td>
</tr>
<tr>
<td>Pflugerville MS</td>
<td>Alerton</td>
</tr>
<tr>
<td>Westview MS</td>
<td>Alerton</td>
</tr>
</tbody>
</table>

C. Provide and install all necessary BACnet compliant hardware and software to meet the system’s functional requirements as listed in these specifications and in the project documents. Provide and install equipment cabinets, panels, control wiring, and other hardware and software required for a complete and code-compliant control system.

D. Provide and install all control power (120, 208, 277 or 480 volt single or three phase) circuits in accordance with the National Electrical Code (NEC) required for the proper operation of the control system in accordance with the project documents. Provide and install any outlets, junction boxes, disconnects, conduit, conductors, raceway and circuit breakers as necessary to provide a complete and operational control system. Connect to the closest branch circuit panel of the proper required voltage and record circuit on as-built documents.

E. Provide the design for hardware layouts, interconnection wiring, and software configuration for submittal review and for development of record documents.

F. Provide start-up services and Owner demonstration, training and support as required by these specifications.

G. Acceptable control system manufacturers include Alerton or Automated Logic. Novar Controls may only be used for the campuses that currently have Novar installed. All other control system manufacturers must be reviewed and approved by the Engineer and Owner prior to bid.

1.2  SYSTEM REQUIREMENTS:

A. All material and equipment used shall be standard components, regularly manufactured and available, not custom designed especially for this project. All systems and components, except site specific
software, shall have previously been thoroughly tested and proven in actual use prior to installation on this project.

B. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.

C. The system must be fully BACnet compatible at the time of installation, meaning that the system must use BACnet as the native communication protocol between distributed controllers communicating on the controller network (i.e. Field Bus). The communication network between controllers is to be EIA-485, using MS/TP at the data link layer. Systems that use proprietary protocol for the main controller field bus are not acceptable.

D. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on an operator’s workstation. All application controllers for terminal units (VAV, FPB, HP, UV, etc.) air handlers, heat recovery units, central plant equipment, and any other piece of controlled equipment shall be fully programmable. No program is to be used in any controller that is not modifiable by the owner. Application controllers shall be mounted next to controlled equipment and communicate with building controller via BACnet LAN. Controllers to be used must be installed and programmed per manufacturer specifications.

E. The site to site communications will be Ethernet. All field logic controllers must be programmed to run the sequence logic in an occupied mode in case of loss in communications between the controllers and the Host.

F. The system must be capable of utilizing a variety of accepted communication protocols including, but not limited to: ODBC, COM, DCOM, etc. System database must be SQL capable. Full, “Schools Interoperability Framework,” compatibility is required.

1.3 EQUIPMENT:

A. All distributed, standalone and unitary controllers supplied shall be in compliance with the following listings and standards:

1. UL916 for Open Energy Management.
   a. FCC Part 15, Sub-Part B, Class A.
   b. CE Electro Magnetic Compatibility.

B. The control system manufacturer shall be ISO9001 listed for design and manufacture of environmental control systems for precise control and comfort, indoor air quality, HVAC plant operation, energy savings and preventative maintenance.

1.4 SUBMITTALS:

A. All submittals must be reviewed and approved by the A/E and Owner prior to installation. Submittals shall include the following at minimum:

1. Graphical displays (in color) representative of the final BAS user interface. Graphical display submittals shall include the following at minimum:
   a. Example graphical display for each unique type of equipment to be controlled by the BAS, including placeholders for all required control points to be shown on the graphic per required points.
   b. Building floor plan views with example zone temperature indication.

2. Programmed control logic representative of the final product required to control each unique type of equipment and system in accordance with the Project Sequences of Operation.
3. Equipment Cut Sheets / Data for all new sensors, actuators, valves, controllers, etc. to be installed in the project.
4. Controller Layouts and Connections
5. Network Diagrams

1.5 DOCUMENTATION AND ACCEPTANCE:

A. Software Programming & Documentation shall contain as a minimum:
   1. Detailed graphical representation of all control algorithms for every piece of mechanical equipment controlled on the project, together with a glossary symbol library detailing the function of each graphical symbol. 'Line by line' computer program documentation is unacceptable.
   2. Detailed description of control sequences used to achieve the specified sequences.

B. Performance Verification Test and Acceptance.
   1. Upon completion of the installation, the Contractor shall start up the system and perform all necessary calibration, testing, and debugging operations. The system shall be demonstrated and verified to perform all operating functions and sequences as detailed in this specification and in the project documents.
   2. All drawings shall be reviewed after the final system checkout and updated or corrected to provide 'as-built' drawings to show exact installation. A floor plan drawing will show LAN and sub-LAN riser as pulled on-site. The system will not be considered complete until the 'as-built' drawings have received their final approval. Electronic record of the as-buitls shall be provided in PDF format.
   3. When the whole system installation and performance is deemed satisfactory and all requirements of this specification are met, the system parts will be accepted for beneficial use and placed under warranty. At this time, a "notice of completion" shall be issued by owner and the warranty period shall start.

PART 2 -PRODUCT HARDWARE

2.1 BUILDING SYSTEMS INTEGRATION:

A. The Building Automation System (BAS) shall establish a seamless interconnection with other building, electrical and/or mechanical subsystems as well as other manufacturers control systems as specified in the project documents. These systems shall be controlled, monitored and graphically programmed through the Graphical User Interface (GUI) software of the BAS.

B. All system information specified in the I/O summary and related documents shall be available to the BAS. Read and write capability, as indicated, shall be provided to the mechanical and electrical equipment indicated and be available to the BAS system. No limits shall be placed by the manufacturer on the owner or BAS with regard to the access, transmission or modification of data provided from the equipment control system.

C. Full cooperation by the Original Equipment Manufacturer in this open protocol effort shall be a requirement for bidding this project. No exceptions shall be allowed and no bid shall be accepted which does not precisely define how the proposed equipment will comply with this section.

D. Other equipment manufacturers shall provide seamless integration through the use of a BACnet microprocessor based communication cards as specified below.
   1. The communication card shall be a microprocessor-based communication device designed to provide seamless, two-way translation between two or more standard or non-standard protocols.
   2. The communication card shall be available for a variety of Data Link/Physical Layer configurations including PTP (point-to-point) via EIA-232, MS/TP via EIA-485, and Ethernet using the IEEE 802.2 standard approved for BACnet.
3. The communication card shall provide full custom programmability of the data flowing between the networks using the same graphical programming as specified herein. The system shall have the ability to create custom building control strategies using global data between networks.

2.2 OPERATOR INTERFACE - Existing

A. Scheduling

1. Operator's workstation shall show all information in easy-to-read daily format including calendar displays. All schedules shall show actual ON/OFF times for each day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.

2. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.

3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

4. Scheduling shall include optional optimum start capability based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set the time that the occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match the zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.

B. Alarm Indication and Handling

1. The BAS interface shall provide audible and visual means of alarm indication, as well as options for printed, email and text message means of alarm indication. The alarm dialog box shall always become the top dialog box regardless of the application(s) currently running. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID's authorization level.

2. System shall provide a log of alarm messages. Alarm log shall be archived to hard drive. Each entry shall include a description of the event-initiating object generating the alarm. Entries shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.

C. Trend Log Information

1. System server shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. Operator shall be able to view all trended records, both stored and archived. All trend log records shall be displayed in standard engineering units.

2. Software that is capable of graphing the trend logged object data shall be included. Software shall be capable of creating two-axis (X, Y) graphs that display up to 10 object types at the same time in different colors. Graphs shall show object values relative to time. Each trend log shall support a custom scale setting for the graph view that is to be stored continuously.

3. Operator shall be able to change trend log setup information, including the information to be logged as well as the interval at which it is to be logged. All input, output, and value object types in the system may be logged. Setup and viewing may be accessed directly from any and all graphics on which object is displayed.

4. Historical data collection and trending shall be exportable to Microsoft Excel.

5. System shall provide interface to track runtime data and preventative maintenance schedules for each piece of equipment.

D. Reports
1. System server shall be capable of periodically producing reports of trend logs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.

2. Reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

E. Field Engineering Tools

1. Provide field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to provide sequencing of all control logic.

2. User-programmed logic shall be downloaded to the controller without any reentry of data required.

3. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define the unit to be controlled.

4. Field engineering tools shall include a Device Manager for detection of devices connected anywhere on the BACnet network by scanning of the entire network. This function shall display device instance, network identification, model number, and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer’s hard drive. If needed, this file shall be downloaded to the appropriate controller.

5. System shall automatically notify the user when a device that is not in the database is added to the network.

6. System shall include backup/restore function that will back up entire system to selected medium and then restore system from that media.

F. Graphical User Interface – Set point modification, equipment status and scheduling should occur through a point and click graphical user interface that eliminates need to access programming for routine event scheduling and/or modification.

G. Calendar Based Equipment Scheduling – Normal operating hours and multiple infinite and self-terminating special events can be programmed ahead of time so that an operator need not be on-site to turn on equipment and adjust set points for planned events.

H. Remote Special Events Scheduling – Web based requests for Schedule exceptions are automatically programmed when request is approved.

I. Control Sequence Programming – Plain English programming code must be used to automate complex building HVAC systems, sustain strict environmental conditions and optimize control functions and applications for the facility.

J. Heating/cooling interlock – Prevent simultaneous heating and cooling operation.

K. Multiple System Set point- Allow separate set point for each stage of heating and/or cooling.

L. Global Programming – Allow for global or individual adjustment of all system parameters by district site building zone or room.

M. Multiple Functionality – System capability to include HVAC system control, irrigation system control, etc.

N. Scalable – System fully capable of future expansion via a building block approach.

O. Sensible Standardization – System should incorporate sensible standardization in that like systems employ the same GUI design, equipment programming and sequence of operation.

P. System shall allow for dehumidification setpoints in unoccupied mode.
Q. Software

1. At the conclusion of project, contractor shall leave with owner a CD ROM that includes backup files of the complete software operation system and project graphics, setpoints, system parameters, etc.

2.3 WEB INTERFACE - Existing

A. Display of Data.

1. Web page graphics and functionality shown on browser shall be no different from the local BAS network. User shall need no additional training to understand information presented on web pages when compared to what is shown on BAS displays. Web page displays shall include animation just as BAS displays.

2. Real-time data shall be shown on all browser web pages. This data must be directly gathered using the BACnet network and automatically updated on browser web page displays without any user action. Data on the browser shall automatically refresh as changes are detected without re-drawing the complete display.

3. It shall be possible for the user to change data from the browser web page if the user is logged on with the appropriate password.

2.4 INPUT-OUTPUT PROCESSING:

A. Universal inputs shall be 0-5VDC - 10K Ohm maximum source impedance, 0-20mA - 24 VDC loop power 250 Ohm input impedance, Dry Contact - 0.5mA maximum current.

B. Analog electronic outputs shall be voltage mode 0-10VDC or current mode 4-20mA.

2.5 ROOM SENSOR

A. Room temperature sensors shall be blank cover display “Smart Sensor” type, including setpoint adjustment limited to setpoint ranges for heating and cooling defined by operator through DDC controller. A run override button shall be provided for the administration area only to operate units during unoccupied periods for predefined time periods set by operator through DDC controller (3 hours maximum).

B. Each sensor shall include an integral humidity sensor for humidity monitoring and control as applicable. Each sensor with unit number shall also include display, configurable to view any combination of room temperature, humidity, outside air temperature, setpoints, etc. LCD digital display to be provided if required (i.e. VRF).

2.6 UNITARY CONTROLLERS:

A. Each Unitary Controller and Unitary Controller Interface shall have LED indication for visual status of communication, power, and all outputs.

B. In the event of a loss of communication with the Unitary Controller Interface, each Unitary Controller shall control from a standalone algorithm which maintains the assigned space temperature until communication with the Unitary Control Module Interface is restored.

2.7 GENERAL PURPOSE/MULTIPLE APPLICATION CONTROLLERS:

A. Each General Purpose/Multiple Application Controller shall execute application programs, calculations, and commands via a microprocessor resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/writeable nonvolatile flash memory within the controller and will be able to upload/download to/from the operator workstation.
B. The General Purpose/Multiple Application Controllers shall be expandable to the specified I/O point requirements. Each controller shall accommodate multiple I/O Expander Modules via a designated expansion I/O bus port. The controller, in conjunction with the expansion modules, shall act as one standalone controller.

C. All point data, algorithms and application software within a controller shall be custom programmable from the operator workstation.

D. Each General Purpose/Multiple Application Controller shall reside on a BACnet communications bus and utilize native BACnet communications between all other controllers and devices on the network. Each controller shall include self-test diagnostics which allow the controller to automatically relay to the network controller any malfunctions or alarm conditions that exceed desired parameters as determined by programming input.

E. Each General Purpose/Multiple Application Controller shall contain both software and firmware to perform full DDC PID control loops.

F. Each General Purpose/Multiple Application Controller shall contain a communication port for the interface of maintenance personnel’s portable computer. All network interrogation shall be possible through this port.

G. All controllers must allow changes to the logic without limitations.

2.8 FIELD HARDWARE/INSTRUMENTATION:

A. The controllers will be mounted and wired in an environment-appropriate steel enclosure. The controller must have a minimum space perimeter of 3" between any terminal block and the enclosure wall. No controllers are to be mounted inside any unit housings which are not specifically designed to be a controls enclosure.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION:

A. Install all miscellaneous devices, hardware, software, interconnections and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

B. Install all individual components in accordance with manufacturer’s instructions.

3.2 LOCATION AND INSTALLATION OF COMPONENTS:

A. Locate and install components for easy accessibility; in general, mount 60 inches above floor with minimum 3'-0" clear access space in front of units. Obtain approval on locations from owner’s representative prior to installation.

B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.

C. All wall-mounted zone temperature/humidity/CO2 sensors must be located near a return air vent and away from any heat inducing source such as, computers, monitors, lamps, coolers, etc. The sensor must not be blocked or covered by any other item other than it factory cover or standard protective or lock box cover, which are well vented. The sensor must be well insulated from infiltration between walls, or from doorways and windows. The sensor must not be in direct contact from the sunlight. Sensors with occupant-adjustable controls or overrides must be mounted per ADA standards.
D. Identify all equipment and control enclosures:
   1. Provide permanently mounted engraved plastic identification tags on all Building Automation System control enclosures.
   2. Provide identification labels on any control modules mounted remotely from the equipment served.
   3. Label control wiring at connections to controllers/equipment.
   4. Label all control wiring junction boxes as “BAS”.

3.3 INTERLOCKING AND CONTROL WIRING:

A. Include all interlock and control wiring as required to enable the functions specified in the project scope of work, control points lists, sequences of operation, and as recommended by equipment manufacturers.

B. All wiring shall be installed neatly and professionally, tight to building structure and parallel to building lines, and in accordance with all national, state and local electrical codes.

C. Cables shall be supported by appropriate straps, hangers, or cable ties spaced at intervals not exceeding 8 feet and within 3 feet of every cabinet, wall-mounted box, or fitting. Where ceiling structure is exposed, additional supports may be required to maintain a clean, inconspicuous appearance and prevent wire from sagging below the bottom of structure. Ceiling grid or light fixture support wires shall not be used to support cables.

D. Cables shall not be run below any air distribution equipment or ductwork unless it serves a device located beneath, and only that portion of cable serving the device is allowed. Cables shall be installed so as not to interfere with equipment maintenance or replacement.

E. Low-voltage control wiring in mechanical, electrical, telephone and data rooms may be installed without raceway where routed horizontally, tight to ceiling structure. Raceways are required for control wiring installed below finished ceilings, or below the bottom of ceiling structure if structure is exposed.

F. Plenum-rated control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner’s representative prior to rough-in.

G. Cables and conductors shall be continuous between outlets, boxes, devices, etc.

H. Include auxiliary pilot duty relays on motor starters as required for control function.

I. Include power for all control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with electrical contractor.

J. If interlock and control wiring is being replaced, the accessible portion of all abandoned wiring shall be removed before installing new wiring.

K. All control wiring shall be neatly bundled and supported from building structure only; not from ceiling wire, etc. Wiring shall be properly tagged and color-coded to meet District standards per electrical specification for control wire color (BAS wiring shall be white). For building additions, route new DDC wiring back to the existing building HVAC control panel.

3.4 FIELD SERVICES:

A. Prepare and start logic control system under provisions of this section.
B. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

C. Provide the capability for off-site monitoring at Owner’s existing office and at the control contractor’s local or main office. At a minimum, the control contractor’s off-site facility shall be capable of system diagnostics and software download.

D. Provide Owner with spare parts list. Identify equipment critical to maintaining the integrity of the operating system.

3.5 TRAINING:

A. Provide application engineer to instruct Owner in operation of systems and equipment.

B. Provide system operator’s training to include (but not limited to) such items as the following: modification of data displays, alarm and status descriptors, requesting data, execution of commands and request of logs.

3.6 DEMONSTRATION:

A. Provide systems demonstration to the reasonable satisfaction of Owner.

B. Demonstrate complete operating system to owner’s representative.

C. Provide certificate stating that control system has been tested

END OF SECTION 23 09 00
SECTION 23 11 23 FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

   A. Section Includes:
      1. Pipes, tubes, and fittings.
      2. Piping specialties.
      3. Piping and tubing joining materials.
      4. Valves.
      5. Pressure regulators.

1.3 DEFINITIONS

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

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

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

1.4 PERFORMANCE REQUIREMENTS

   A. Minimum Operating-Pressure Ratings:
      1. Piping and Valves: 100 psig minimum unless otherwise indicated.
      2. Service Regulators: 65 psig minimum unless otherwise indicated.

1.5 ACTION SUBMITTALS

   A. Product Data: For each type of the following:
      1. Piping specialties.
      2. Corrugated, stainless-steel tubing with associated components.
      3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
      4. Pressure regulators. Indicate pressure ratings and capacities.
      5. Dielectric fittings.

1.6 INFORMATIONAL SUBMITTALS

   A. Welding certificates.

   B. Field quality-control reports.
1.7 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For motorized gas valves and pressure regulators to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE
   A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
   C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
   B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
   C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
   D. Protect stored PE pipes and valves from direct sunlight.

1.10 PROJECT CONDITIONS
   A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
   B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
      1. Notify Architect no fewer than two days in advance of proposed interruption of natural-gas service.
      2. Do not proceed with interruption of natural-gas service without Architect's written permission.

1.11 COORDINATION
   A. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS
   A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
   a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. OmegaFlex, Inc.
      b. Parker Hannifin Corporation; Parflex Division.
      c. Titeflex.
      d. Tru-Flex Metal Hose Corp.
   3. Coating: PE with flame retardant.
      a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
         1) Flame-Spread Index: 25 or less.
         2) Smoke-Developed Index: 50 or less.
   4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
   5. Striker Plates: Steel, designed to protect tubing from penetrations.
   6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
   7. Operating-Pressure Rating: 5 psig.
C. PE Pipe: ASTM D 2513, SDR 11.
   1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
   2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
      b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
      c. Aboveground Portion: PE transition fitting.
      d. Outlet shall be threaded or flanged or suitable for welded connection.
      e. Tracer wire connection.
      f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

   a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
   b. Outlet shall be threaded or flanged or suitable for welded connection.
   c. Bridging sleeve over mechanical coupling.
   d. Factory-connected anode.
   e. Tracer wire connection.
   f. Ultraviolet shield.
   g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Lyall, R. W. & Company, Inc.
      2) Mueller Co.; Gas Products Div.
      3) Perfection Corporation; a subsidiary of American Meter Company.
   b. PE body with molded-in, stainless-steel support ring.
   c. Buna-nitrile seals.
   d. Acetal collets.
   e. Electro-zinc-plated steel stiffener.

6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Lyall, R. W. & Company, Inc.
      2) Mueller Co.; Gas Products Div.
      3) Perfection Corporation; a subsidiary of American Meter Company.
   b. Fiber-reinforced plastic body.
   c. PE body tube.
   d. Buna-nitrile seals.
   e. Acetal collets.
   f. Stainless-steel bolts, nuts, and washers.

7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Dresser Piping Specialties; Division of Dresser, Inc.
      2) Smith-Blair, Inc.
   b. Steel flanges and tube with epoxy finish.
   c. Buna-nitrile seals.
   d. Steel bolts, washers, and nuts.
   e. Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
2. **Indoor, Movable-Appliance Flexible Connectors**: Comply with ANSI Z21.69.
4. **Corrugated stainless-steel tubing with polymer coating**.
5. **Operating-Pressure Rating**: 0.5 psig.
6. **End Fittings**: Zinc-coated steel.
7. **Threaded Ends**: Comply with ASME B1.20.1.
8. **Maximum Length**: 72 inches.

**B. Quick-Disconnect Devices**: Comply with ANSI Z21.41.
1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

**C. Y-Pattern Strainers**:
1. **Body**: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. **End Connections**: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. **Strainer Screen**: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. **CWP Rating**: 125 psig.

**D. Weatherproof Vent Cap**: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

### 2.3 JOINING MATERIALS

**A. Joint Compound and Tape**: Suitable for natural gas.

**B. Welding Filler Metals**: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

### 2.4 MANUAL GAS SHUTOFF VALVES

**A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.**

**B. General Requirements for Metallic Valves, NPS 2 and Smaller**: Comply with ASME B16.33.
1. **CWP Rating**: 125 psig.
2. **Threaded Ends**: Comply with ASME B1.20.1.
3. **Dryseal Threads on Flare Ends**: Comply with ASME B1.20.3.
5. **Listing**: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. **Service Mark**: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

**C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger**: Comply with ASME B16.38.
1. **CWP Rating**: 125 psig.
2. **Flanged Ends**: Comply with ASME B16.5 for steel flanges.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. BrassCraft Manufacturing Company; a Masco company.
   c. Lyall, R. W. & Company, Inc.
   e. Perfection Corporation; a subsidiary of American Meter Company.

3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Flowserve.
   b. Homestead Valve; a division of Olson Technologies, Inc.
   d. Milliken Valve Company.
   e. Mueller Co.; Gas Products Div.

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Actaris.
   b. American Meter Company.
   c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   d. Invensys.
   e. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.


1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Actaris.
   b. American Meter Company.
   c. Eclipse Combustion, Inc.
   d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   e. Invensys.
   f. Maxitrol Company.
   g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 5 psig.


1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Canadian Meter Company Inc.
b. Eaton Corporation; Controls Div.
c. Harper Wyman Co.
d. Maxitrol Company.
e. SCP, Inc.

5. Seat Disc: Nitrile rubber.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Central Plastics Company.
   d. Jomar International Ltd.
   e. Matco-Norca, Inc.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.

2. Description:
   b. Pressure Rating: 125 psig minimum at 180 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Central Plastics Company.
   c. Matco-Norca, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.

2. Description:
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 125 psig minimum at 180 deg F.
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig.
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

2.7 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
   1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:
   1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

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

F. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

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

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

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

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

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

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
   1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
   a. Exception: Tubing passing through partitions or walls does not require striker barriers.
5. Prohibited Locations:
   a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   b. Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

Z. Provide a valved connection to the existing main gas supply line at a point where such line is large enough to support a branch feeding all gas needs in the new addition. Gas piping shall be located underground only when necessary and shall have a dirt-leg prior to entry to the gas valve above grade.

AA. Gas piping shall be run exposed on roof surfaces and supported on full curbs with corrosion resistant pipe rollers. Maintain a minimum of 6 inches to bottom of piping from finished roof surface.

BB. No exposed gas piping shall be run in buildings except for low pressure drops to individual equipment and piping within a room connecting appliances within a single area. Where gas piping must penetrate
building walls, provide ventilated sleeves to the exterior. No gas piping shall be run below crawl spaces or in return air plenums.

CC. Gas service riser mounted against the exterior wall shall be suitably guarded with masonry channels integrated into the wall system, so as to protect against climbing and scaling of pipe riser.

DD. Install regulators designed for outdoor use at exterior of building. A test tee with nipple and cap should be provided downstream of each regulator.

EE. Each gas piping system shall be installed so the system can be tested in accordance with the Texas Administrative Code and Railroad Commission. Provide test ports for gauges and air intake lines to pump up system, located such that the system can be tested without having to break down the gas piping. (Ref: Texas Administrative Code, Title 16, Part 1, Chapter 7, Subchapter Rule 7.74).

FF. Regulator discharge shall not be less than 10’ from any air conditioning intake.

GG. Unions should be provided on each side of each regulator.

HH. A stopcock should be provided at the meter (if a new meter is required) on each side of each regulator.

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of appliance connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

C. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
   5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
   2. Bevel plain ends of steel pipe.
   3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
   5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
   2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
   3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Paint exterior gas piping after installation with corrosion resistant primer and severe service paint system. Paint exposed piping visible from occupiable areas a color to match building trim. Paint all other piping run in mechanical areas and on roof yellow.
3.11 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE
A. Underground natural-gas piping shall be the following:
   1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
B. Aboveground natural-gas piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints (2" and smaller).
   2. Steel pipe with wrought-steel fittings and welded joints (above 2").

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG
A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
B. Aboveground, distribution piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.
C. Underground, below building, piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

3.14 INDOOR PIPING SCHEDULE
A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
B. Aboveground, distribution piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with steel welding fittings and welded joints.
C. Underground, below building, piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.
3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller shall be the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
   1. Cast-iron, lubricated plug valve.

END OF SECTION 23 11 23
SECTION 23 23 00 REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer’s test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Shop Drawing Scale: 1/4 inch equals 1 foot.
   2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.
1.7 QUALITY ASSURANCE
   B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING
   A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION
   A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS
   A. Copper Tube: ASTM B 280, Type ACR.
   B. Wrought-Copper Fittings: ASME B16.22.
   C. Brazing Filler Metals: AWS A5.8.
   D. Flexible Connectors:
      2. End Connections: Socket ends.
      3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch long assembly.
      5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES
   A. Diaphragm Packless Valves:
      1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
      3. Operator: Rising stem and hand wheel.
      5. End Connections: Socket, union, or flanged.
      7. Maximum Operating Temperature: 275 deg F.
   B. Packed-Angle Valves:
      1. Body and Bonnet: Forged brass or cast bronze.
      2. Packing: Molded stem, back seating, and replaceable under pressure.
      3. Operator: Rising stem.
      5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
8. Maximum Operating Temperature: 275 deg F.

C. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
4. End Connections: Copper spring.

D. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
7. Maximum Operating Temperature: 240 deg F.

E. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Reverse-flow option (for heat-pump applications).
7. End Connections: Socket, flare, or threaded union.

F. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
5. Seat: Polytetrafluoroethylene.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
11. Maximum Operating Temperature: 240 deg F.

G. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
6. Maximum Operating Temperature: 275 deg F.
H. Moisture/Liquid Indicators:
   2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   3. Indicator: Color coded to show moisture content in ppm.
   5. End Connections: Socket or flare.
   7. Maximum Operating Temperature: 240 deg F.

I. Replaceable-Core Filter Dryers: Comply with ARI 730.
   1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   4. Designed for reverse flow (for heat-pump applications).
   5. End Connections: Socket.
   9. Maximum Operating Temperature: 240 deg F.

J. Receivers: Comply with ARI 495.
   1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   2. Comply with UL 207; listed and labeled by an NRTL.
   4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
   5. End Connections: Socket or threaded.
   7. Maximum Operating Temperature: 275 deg F.

K. Liquid Accumulators: Comply with ARI 495.
   2. End Connections: Socket or threaded.
   4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Atofina Chemicals, Inc.
   2. DuPont Company; Fluorochemicals Div.
   3. Honeywell, Inc.; Genetron Refrigerants.
   4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.
PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type [ACR] [L (B)], annealed- or drawn-temper tubing and wrought-copper fittings with [brazed] [or] [soldered] joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

D. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

E. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

F. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

G. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Hot-gas bypass valves.
   4. Compressor.

H. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

I. Install receivers sized to accommodate pump-down charge.

3.3 PIPING INSTALLATION

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

B. Install refrigerant piping according to ASHRAE 15.

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

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

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

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Refer to Section 23 09 00 "Instrumentation and Control for HVAC" and Section 23 09 93 "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Section 23 05 53 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors.
T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

D. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
   a. Fill system with nitrogen to the required test pressure.
   b. System shall maintain test pressure at the manifold gage throughout duration of test.
   c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
   d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer’s written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00
SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Single-wall round ducts and fittings.
   4. Duct liner.
   5. Sealants and gaskets.
   6. Hangers and supports.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.

B. Design Submittal:
   1. Sheet metal thicknesses.
   2. Joint and seam construction and sealing.
   3. Reinforcement details and spacing.
   4. Materials, fabrication, assembly, and spacing of hangers and supports.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure
C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Lindab Inc.
   b. McGill AirFlow LLC.
   c. SEMCO Incorporated.
   d. Sheet Metal Connectors, Inc.
   e. Lewis & Lambert.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.
C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
   2. Maximum Thermal Conductivity:
      a. Type I, Flexible: 0.27 Btu x in./h x sq. ft x deg F at 75 deg F mean temperature.
   3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NFTL and registered by the EPA for use in HVAC systems.
   4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
      a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2" galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

D. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   5. Mold and mildew resistant.
   6. VOC: Maximum 35 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
F. Trapeze and Riser Supports:

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead.

C. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

D. Repair or replace damaged sections and finished work that does not comply with these requirements.
3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
3.8 DUCT SCHEDULE

A. Duct Pressure Class: Positive/Negative 2-inch wg.

B. Duct Minimum SMACNA Seal Class: A

C. Duct SMACNA Leakage Class: 6.

D. Duct Construction Type:
   1. Ductwork concealed in mechanical closets or above ceilings shall be single wall duct as indicated on drawings.
   2. Ductwork shall be internally lined with fibrous glass, Type I, 1-1/2 inch thick (R-6).

E. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
   2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
      a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      b. Radius-to Diameter Ratio: 1.5.
      c. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
      d. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
      a. Rectangular Main to Rectangular Branch: 45-degree entry.
      b. Rectangular Main to Round Branch: 45 degree or high efficiency tap.
   2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
      a. 45 or 90-degree tap and conical tap as indicated on the drawings.

END OF SECTION 23 31 13
SECTION 23 33 00  AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   2. Fire dampers.
   3. Combination Fire and Smoke Dampers
   4. Turning vanes.
   5. Remote damper operators (Concealed Regulators).
   6. Flexible connectors.
   7. Flexible ducts.
   8. Duct-mounted access doors.
   9. Duct accessory hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION


B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   2. Exposed-Surface Finish: Mill phosphatized.
B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Air Balance Inc.; a division of Mestek, Inc.
   b. McGill AirFlow LLC.
   c. Nailor Industries Inc.
   d. Pottorff.
   e. Ruskin Company.
   f. Trox USA Inc.
   g. Vent Products Company, Inc.

2. Standard leakage rating.

3. Suitable for horizontal or vertical applications.

4. Frames:
   a. Hat-shaped, 0.094-inch thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:
   a. Multiple or single blade.
   b. Opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch thick.


7. Bearings:
   a. Oil-impregnated bronze or molded synthetic.

8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage Manual Volume Dampers:

C. Jackshaft:

1. Size: 0.5-inch diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   4. Nailor Industries Inc.
   5. Prefco; Perfect Air Control, Inc.
   6. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm (20-m/s) velocity.

D. Fire Rating: 1-1/2 hours; unless indicated otherwise.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: As required by UL listing, and of length to suit application.
   2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

I. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

2.5 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   4. Nailor Industries Inc.
   5. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) velocity.
D. Fire Rating: 1-1/2 hours; unless indicated otherwise.

E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

G. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

H. Leakage: Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application, thickness as required by UL listing.

K. Damper Motors: Two-position action, 120 volt electric.

L. Accessories:
   1. Auxiliary switches for signaling or position indication.
   2. Test and reset switches, damper mounted.
   3. Relay for connection to fire alarm system.

2.6 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Ductmate Industries, Inc.
   b. Duro Dyne Inc.
   c. Elgen Manufacturing.
   d. METALAIRE, Inc.
   e. SEMCO Incorporated.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single wall.

2.7 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Pottorff.
   2. Ventfabrics, Inc.
   3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.
C. Cable: Steel.

D. Wall-Box Mounting: Recessed.

E. Wall-Box Cover-Plate Material: Stainless steel.

2.8 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Inc.
   3. Ventfabs, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.
   1. All coatings shall be required to meet the most current VOC limits of SCAQMD r1113.
   2. All adhesives shall be required to meet the most current VOC limits of SCAQMD r1168.

   1. Minimum Weight: 30 oz./sq. yd.
   2. Tensile Strength: 500 lbf/inch in the warp and 500 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd.
   2. Tensile Strength: 500 lbf/inch in the warp and 500 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

2.9 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.

B. Insulated, Flexible Duct for Medium and High Pressure Systems: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
   1. Pressure Rating: 12-inch wg positive and 5-inch wg negative.
   2. Maximum Air Velocity: 5500 fpm (20 m/s).
   3. Temperature Range: Minus 10 to plus 160 deg F.
   4. Insulation R-value: R-6..

C. Insulated, Flexible Duct for Low Pressure Systems: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
   1. Pressure Rating: 6-inch wg positive and 4-inch wg negative.
   3. Temperature Range: Minus 20 to plus 175 deg F.

D. Insulated, Flexible Duct (Where all metal duct is required): UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
   1. Pressure Rating: 6-inch wg positive and 4-inch wg negative.
   3. Temperature Range: Minus 20 to plus 210 deg F.

E. Flexible Duct Connectors:
   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap in sizes 3 through 18 inches, to suit duct size. Refer to Drawings for required type.

2.10 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. American Warming and Ventilating; a division of Mestek, Inc.
   2. Ductmate Industries, Inc.
   3. Flexmaster U.S.A., Inc.
   5. McGill AirFlow LLC.
   6. Nailor Industries Inc.
   7. Pottorf.

   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
      c. Access Doors up to 24 by 48 Inches: Two compression latches with inside handles.
      d. Access Doors Larger Than 24 by 48 Inches: Continuous and three compression latches with outside and inside handles.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts as required to afford complete control of the air flow in the various duct systems. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. Downstream from control dampers, backdraft dampers, and equipment.
   5. Upstream and downstream from duct silencers.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links.
   7. Control devices requiring inspection.
   8. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 8 inches.

K. Install flexible connectors to connect ducts to equipment.
L. Connect terminal units to supply ducts directly or with maximum 24-inch lengths of flexible duct as detailed on the drawings. Do not use flexible ducts to change directions.

M. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with worm gear clamps.

O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Inspect turning vanes for proper and secure installation.
   4. Operate remote damper operators to verify full range of movement of operator and damper.
   5. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

END OF SECTION 23 33 00
SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.
B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Acme Engineering & Manufacturing Corporation.
   2. Greenheck Fan Corporation.
   3. Loren Cook Company.
   4. PennBarry.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
   2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty re-greaseable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
   5. Fan and motor isolated from exhaust airstream.

E. Direct drive fans shall be provided with ECM motors with manual speed adjustment.

F. Accessories:
   1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   2. Overall Height: 9-1/2 inches/18 inches.
   4. Vented Curb: Where indicated on detail on the drawings provide unlined curbe with louvered vents in vertical sides.
2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support utility vent set units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install floor-mounted units on concrete bases.

D. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

E. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

F. Support suspended units from structure using threaded steel rods and elastomeric hangers. Vibration-control devices are specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."

G. Install units with clearances for service and maintenance.

H. Label units according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment and connect wiring according to Division 26.
3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   10. Shut unit down and reconnect automatic temperature-control operators.
   11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 23 05 93 “Testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 23 34 23
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fan-powered air terminal units.

1.3 SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Air terminal units.
2. Liners and adhesives.
3. Sealants and gaskets.

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, sprinklers, access panels, and special moldings.

D. Field quality-control reports.

E. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Project Closeout,” include the following:

1. Instructions for resetting air volumes.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
1.5 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Powered-Unit Filters: Furnish one spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 SERIES FAN-POWERED AIR TERMINAL UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Titus Model DFLS or comparable product by one of the following:

1. Price Industries.
2. Trane

B. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud for horizontal installation above a ceiling and for vertical installation on a wall. Terminal depth shall not exceed 10-1/2 inch.

C. Casing: 0.034-inch (20 gauge) galvanized steel, single wall.

1. Casing Lining: Adhesive attached, 1/2-inch- thick, 1-1/2 pound density polymer foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
2. Air Inlets: Round or rectangular connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
5. Fan: Dynamically balanced, forward-curved centrifugal, constructed of steel.

D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 5 percent of nominal airflow at 1-inch wg inlet static pressure.

E. Velocity Sensors: Multipoint array with velocity sensors in cold-deck air inlets and air outlets.

F. Motor:

1. Electronically commutated motor (ECM) variable speed DC brushless.
2. Operated by a single phase integrated controller/inverter.
4. Integral built-in soft start and soft speed change ramp.
5. Motor capable of horizontal or vertical mounting.
6. Permanently lubricated ball bearings.
7. Motor directly coupled to forward curve fan.
8. Motor capable of overcoming reverse rotation and not affect life expectancy.
G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Material: Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
   2. Thickness: 1 inch.

H. Hydronic Coils: Minimum wall thickness of 0.016 inch copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Performance data shall be based on tests run in accordance with ARI Standard 410.

I. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
   1. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
   2. Disconnect Switch: Factory-mounted.

J. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

2.2 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

C. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.
   1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts appropriate for construction materials to which hangers are being attached.
1. Do not use powder-actuated concrete fasteners.

3.3 CONNECTIONS
A. Install piping adjacent to air terminal unit to allow service and maintenance.
B. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."
C. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

3.4 IDENTIFICATION
A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL
A. Perform tests and inspections.
B. Tests and Inspections:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Air terminal unit will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.6 STARTUP SERVICE
A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION
A. Train Owner’s maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00
SECTION 23 37 13  DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. All air distribution devices as scheduled on the drawings.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated, include the following:
1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS
A. Diffuser, Grilles and Registers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. METALAIRE, Inc.
   b. Nailor Industries Inc.
   c. Price Industries.
   d. Titus.

2.2 SOURCE QUALITY CONTROL
A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
SECTION 23 81 19  SELF-CONTAINED AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged air-conditioning units with refrigerant compressors and controls, intended for outdoor installations, with integral air-cooled condensers.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For self-contained air-conditioners to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


C. Units shall be designed to operate with HCFC-free refrigerants.

1.5 COORDINATION

A. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 07 Section "Roof Accessories."

1.6 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
B. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of self-contained air-conditioners that fail in materials or workmanship within specified warranty period.

1. Include a full five year parts and labor warranty from date of Substantial Completion. Warranty services shall be provided by factory representative (authorized contractor is not acceptable).
2. Failures include, but are not limited to, refrigeration components, airside components, electrical components, and controls.
3. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer’s standard, but not less than 15 years from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Two sets of filters for each unit.
2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. Integral Air-Cooled, Self-Contained Air-Conditioners 20 Tons and Smaller:
   a) Lennox
   b) Alternative manufacturers shall only be considered through request as voluntary bid alternates.

2.2 PACKAGED UNITS

A. Description: Units furnished and installed shall be gas heating/electric cooling packaged rooftops as scheduled on contract documents and these specifications. Cooling capacity ratings shall be ARI Standard 210 certified. Units shall consist of insulated weather tight casing with compressors, air cooled condenser coil, condenser fans, evaporator coil, return air filters, supply motors and drives, gas furnace section.

B. Unit shall be provided with phase and brownout protection which shuts down all electrical components in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

C. Units shall be 100% factory run tested and fully charged with non-HCFC sustainable refrigerant (R-410a).

D. Units shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas. Wiring internal to the unit shall be colored and numbered for identification.

E. Capacity: Some latitude will be allowed to compensate for differing unit manufacturers. However, units shall not be submitted with total capacity less than 10% below the scheduled capacity nor less than 5% of the sensible capacity.
F. Cabinet: Galvanized steel, phosphatized, and finished with an air-dry paint coating with hinged access panels. Structural members shall be 16 gauge with access doors and removable panels of minimum 20 gauge. Units cabinet surface shall be tested 500 hours in salt spray test in compliance with ASTM B117. Cabinet construction shall allow for all service/maintenance from one side of the unit.

1. Cabinet top cover shall be one piece construction or where seams exists, it shall be double hemmed and gasket sealed.
2. Downflow unit's base pans shall have a raised 1 1/8 inch high lip around the supply and return openings for water integrity.
3. Access Doors: Water and air tight panels with hinges and handles shall provide access to filters, heating section, supply air fan section, evaporator coil section, and unit control section.
4. Insulation: Provide 1/2 inch thick coated fiberglass insulation on all exterior panels in contact with the return and conditioned air stream.

G. Air Filters: Factory installed filters shall mount integral within the units and shall be accessible thru access panels. One inch thick glass fiber disposable media filters shall be provided with the provisions within the unit for 2 inch thick filters to be field provided and installed.

H. Provide two sets of 2" MERV 8A filters for installation at occupancy.

I. Fans and Motors: Provide evaporator fan section with forward curved, double width, double inlet, centrifugal type fan. Provide self-aligning, grease lubricated, ball or sleeve bearings with permanent lubrication fittings. Provide units with either direct drive electronically commutated multiple speed, dynamically balanced supply fans, or belt driven supply fans with a VFD and adjustable motor sheaves. VFDs for belt driven fans shall vary the speed of the fan according to factory configured heating/cooling stages. Outdoor fans shall be direct drive, statically and dynamically balanced, draw through in the vertical discharge position. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil. Indoor motors shall be ECM type with variable speed control.

J. Gas Furnace Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.
2. Burners:
   a) Fuel: Natural gas.
   b) Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.

5. Safety Controls:
   a) Gas Control Valve: multiple stage (2-stage minimum).

K. Evaporator Coil: Provide configured aluminum fin surface mechanically bonded to copper tubing coil.

L. Provide drain pan for base of evaporator coil constructed of stainless steel with external connections.

M. Condenser Section: Provide internally finned 3/8" seamless copper tube mechanically bonded to aluminum fins. Factory pressure tested to 450 psig.

1. Provide vertical discharge, direct drive fans with aluminum blades. Fans shall be statically balanced. Motors shall be permanently lubricated, with integral thermal overload protection in a weather tight casing.
N. Hail Guard Screen: Entire condenser coil shall be covered with louvered hail guards or 18 gauge, 1/2" mesh galvanized wire screen. The screen shall be installed on the 24 gauge stand-off clips to allow 1" clearance between coil and screen.

O. Refrigeration System: Provide scroll compressors with internal suction and discharge valves, crankcase heater, and centrifugal oil pump. Internally isolated motors on springs. Provide suction gas cooled motor with over temperature and over current protection. Compressors shall be warrantied for 5 years.

1. Units shall be provided with modulating, or 2-stage dual, scroll compressors to maintain capacity control and discharge air temperature in accordance with airflow modulation.
2. Provide an independent expansion device for each refrigeration circuit. Factory pressure test at 450 psig and leak tested at 200 psig.
3. Units shall have cooling capabilities down to 0 degree F as standard or manufacturer shall furnish unit with installed low ambient controls to allow for operation down to 0 degree F. For field installed low ambient accessory, the manufacturer shall provide a factory authorized serviceman that will assure proper installation and operation.
4. Provide with thermostatic temperature control in the compressor windings, to protect against excessive temperatures, high and low pressure conditions.
5. Provide each unit with factory supplied and piped liquid line filter drier, suction and liquid line Schraeder valves.

P. Provide unit with hot-gas reheat coil for humidity control with on/off or modulating operation solenoid valve.

Q. Outside Air: Provide full modulating economizer with outside air intake, hood, inlet screen, and automatic modulating dampers to meet sequence of operations and to close when unit is not operating. Provide unit with barometric relief damper for gravity relief operation. During economizer operation, a mixed-air temperature control shall modulate the outdoor and return air damper assembly to prevent the supply air temperature from dropping below 55 deg. F. Changeover from compressor to economizer operation shall be provided by an integral electronic enthalpy control that feeds input into the basic module. The economizer's minimum position shall be configurable to vary based on the supply fan speed and demand control ventilation with CO2 monitoring.

R. Controls: Units shall be provided with BACnet certified control card capable of integration into Alerton BAS system. All points shall be monitored by BAS system and BAS system shall be able to control start/stop of unit, calendar based scheduling (with special event capabilities), temperature setpoints, and dehumidification setpoints.

S. Microprocessor Control Panel: Controls unit functions as standalone or network operation, including refrigeration and safety controls, with unit-mounted display, and the following:

1. Supply fan.
2. Supply-fan motor speed.
3. Compressors.
5. Economizer control.
6. Panel-mounted control switch to operate unit in remote or local control mode or to stop or reset.
7. Panel-mounted indication of the following:
   a) Operating status.
   b) System diagnostics and safety alarms.
   c) Supply-air temperature and set point.
   d) Space temperature and setpoint

T. Unit shall be provided with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24V transformer side.
U. Roof Mounting Frame: Roof curbs shall be factory provided to maintain top of curb 12” above the surface of the roof. Coordinate requirements with roof plans and details. Units serving noise sensitive areas shall be installed on vibration isolation curb as noted below. Refer to drawings and schedules for additional requirements.

1. If vibration curb is not scheduled, provide unit with a standard curb: A prefabricated 14-gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14” high and include a nominal 2” x 4” wood nailing strip. Gasket shall be provided for field mounting between the unit base and the roof curb.

V. Vibration / Noise Isolation Curb: Units specified with vibration curbs shall be installed on isolated Vibro-Acoustics type NCC-VCR-25849 roof top spring isolated noise control curb consisting of galvanized curb sections with integral vertical and laterally restrained isolators formed to fit the contractor supplied rooftop equipment. The spring isolation curb and acoustical treatment package shall provide a space and adjacent space noise criteria as listed in the schedule.

1. The silencing elements and the spring isolation elements shall be built complete by the noise control manufacturer as an integral unit roof curb or as described on the schedule.
2. The noise control curb shall bear directly on the roof structure and shall be flashed and waterproofed into the roof’s membrane waterproofing system by the installing contractor within the specification and requirements of the roofing system to maintain all roof warranties.
3. If products other than those of the basis of design noise control manufacturer are supplied on the project, the purchasing Contractor assumes full performance, project schedule and monetary responsibility for meeting the project noise criteria, including any retrofit work that may be required.
4. Submittals: If other than the basis of design, the noise control manufacturer shall provide the following acoustical and pressure drop calculations, stamped by a professional engineer, as part of the submittal package to demonstrate that the resultant noise levels in the indoor occupied spaces served by the rooftop equipment meet the above noise criteria and maximum allowable pressure drop including system effects:
   a) Airborne noise through supply air ducts
   b) Airborne noise through return air ducts
   c) Breakout noise through all ducts
   d) Transmission noise from bottom of unit through the roof
   e) Supply air pressure drop including system effects
   f) Return air pressure drop including system effects

5. Submittals shall include PE stamped, IBC or NBC code compliant overturn calculations for site specific wind and seismic conditions. Calculations shall be clearly typed or printed, not handwritten.
6. Submittals shall include a written test report by a third party organization showing airside silencing elements have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.
7. Performance: The total noise contribution from other sources other than the AHU’s must be at least 5 dB below the specified noise criteria. Sound power levels of actual equipment to be installed on project shall be used for the submitted analysis.
   a) If the noise level in the occupied spaces exceeds the specified noise criteria level, it will be the financial responsibility of the noise control manufacturer to provide product and labor to achieve the specified criteria. The project schedule is based on the sound power levels of the “basis of design” air handling units. Additional noise control required as a result of the purchase of noisier air handling units will be the financial responsibility of the purchasing Contractor.
b) Site performance verification will be conducted by an acoustical consultant commissioned by the Mechanical Engineer to ensure the specified performances have been attained.

c) Onsite sound measurements shall be made using a Type 1 integrating sound level meter as defined in the latest versions of ANSI S1.4, ANSI S1.11, and ANSI S1.43. The meter shall utilize parallel octave or 1/3-octave band filters, where all frequency bands are processed simultaneously. Sound measurements shall be un-weighted, time averaged equivalent sound pressure levels (Leq).

d) The measurements shall be conducted by an independent acoustical consulting firm that is a member of the National Council of Acoustical Consultants. The measurements shall be conducted in accordance with the Engineering Method of the Room Noise Measurement procedure outlined in the 2011 ASHRAE Handbook – HVAC Applications.

8. Noise Control Curb Construction:
   a) Silencing elements shall be constructed of ASTM A 653/A 653M G90 galvanized steel, with fiberglass acoustic media fill protected from erosion by a perforated steel liner. Where indicated on schedule, silencer shall have High Transmission Loss (HTL) casing to prevent break-out noise.
   b) Noise control curb must have STC rated acoustic floor barrier provided by the same manufacturer. The barrier is made up of galvanized double acoustic panels ship in pieces to site for installation. Contractor must install per manufacturer standard procedures.
   c) The curb shall be constructed from a minimum of 16 ga G90 galvanized perimeter steel with a factory attached wood nailer. The perimeter steel seams shall be continuously welded. The galvanized perimeter curb steel shall be attached to a structural steel frame that incorporates a minimum of 4 restrained spring isolators that support the rooftop unit.
   d) The curb shall have factory installed lifting points
   e) Curb sides and ends shall be capable of accepting 51 mm (2") external insulation for field installation by the installing contractor.
   f) The isolation springs shall be of the vertical and laterally restrained type. The springs shall be designed to be laterally stable and properly selected to provide minimum specified deflection with 50% additional travel to solid. Isolation springs shall be powder coated for corrosion resistance and have a minimum static spring deflection of 2" as scheduled.
   g) The curb shall be constructed to match the pitch of the roof.
   h) The isolation shall allow 6 mm (¼") movement before resisting wind loads in any lateral direction.
   i) Where required by the project specification the isolation curb shall be designed to meet all seismic loads and wind loading as defined by the building code having jurisdiction.
   j) The perimeter of the curb shall have a flexible neoprene air and weather seal joining the upper and lower curb sections. There shall also be a continuous closed cell sponge material between the top of the spring isolation curb and underside of the rooftop unit to provide a waterproof seal.
   k) The spring isolation curb shall be shipped pre-assembled where possible. Where size prohibits one piece shipping, the isolation curb shall be split into a minimum number of sections and all connecting hardware shall be supplied by the manufacture. Additional acoustic accessories shall be shipped loose for field installation.
   l) All acoustic installation hardware shall be provided by the isolation curb manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install units level and plumb.
   B. Anchor units to structure.
3.2 CONNECTIONS

A. Install piping adjacent to unit to allow service and maintenance.

B. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to self-contained air-conditioners with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory service technician (authorized representative not acceptable) to inspect, test, and adjust field-assembled components and equipment installation, including connection, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory service technician (authorized representative not acceptable) to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

B. Manufacturer shall demonstrate operation of control sequence to Owner's third-party Commissioning Authority and obtain his signature as a condition for acceptance. These sequences will be independent of the controls integration via BACnet card.

END OF SECTION 23 81 19
SECTION 23 81 26  
SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include certified sound-power ratings, rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
   2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

D. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

E. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

F. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 240 and bear the AHRI Certification label.

G. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

H. A dry air holding charge shall be provided in the indoor section.
I. Delivery, Storage and Handling

1. Unit shall be stored and handled according to the manufacturer’s recommendations.
2. The wireless controller shall be shipped inside the carton with the indoor unit and able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.6 COORDINATION

A. Coordinate sizes and locations of equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Parts: The units shall have a manufacturer’s parts and defects warranty for a period five (5) years from date of installation. The compressor shall have a warranty of seven (7) years from date of installation.
   b. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

   1. Mitsubishi
   2. Daikin
   3. LG
   4. Sanyo

2.2 INDOOR UNITS (3 TONS OR LESS)

A. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board, fan and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit shall be charged with dry air before shipment from factory.

B. Unit Cabinet:

   1. The casing shall have a white finish
   2. Multi directional drain connection and refrigerant piping, offering three (3) direction pipe alignments for all refrigerant piping and two (2) direction pipe alignments for condensate draining shall be standard.
   3. There shall be a separate, metal back-plate that secures the indoor unit firmly to the wall. Secure mounting of plate and all mounting hardware shall be furnished by and be the responsibility of the installer.

C. Fan:

   1. The indoor unit fan shall be an assembly with a line-flow fan direct driven by a single motor.
   2. The fan shall be statically and dynamically balanced and be powered by a motor with permanently lubricated bearing.
3. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
   a. Indoor units shall have a “Wide Vane” feature to distribute airflow over a wide – 150 degree – angle from right to left to provide comfort over a wider area.
4. An integral, motorized, multi-position, horizontal air sweep flow louver shall provide for uniform air distribution, up and down.
5. The indoor fan shall operate at of four (4) selectable speeds: Powerful, High, Medium and Low.

D. Filter: Return air shall be filtered by means of easily removed, washable, Pre-filter and an Anti-allergy enzyme filter – blue, pleated type.

E. Coil:
   1. The indoor unit coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   2. The tubing shall have inner groves for high efficiency heat exchange.
   3. All tube joints shall be brazed with phosphocopper or silver alloy.
   4. The coils shall be pressure tested at the factory.
   5. A sloped, corrosion resistant condensate pan with drain shall be provided under the coil. A condensate mini-pump shall be provided to provide a means of condensate disposal when a gravity drain is not available.
   6. A drain pan level switch, designed to connect to the control board, shall be provided, and installed on the condensate pan to prevent condensate from overflowing.

F. Electrical:
   1. The unit electrical power shall be 208-230 volts, 1-phase, 60 hertz.
   2. The system shall be equipped with A-Control – a system directing that the indoor unit be powered directly from the outdoor unit using a 3-wire connection plus ground.
   3. The indoor unit shall not have any supplemental electrical heat elements.

2.3 OUTDOOR UNITS (3 TONS OR LESS)

A. General: The outdoor units are specifically designed to work with the indoor units. The outdoor units must have a thermally fused powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.

B. Unit Cabinet: The casing shall be fabricated of galvanized steel, bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.

C. Fan:
   1. The unit shall be furnished with a direct drive propeller type fan.
   2. The outdoor unit fan motor shall be a direct current (DC) motor and have permanently lubricated bearings.
   3. The fan motor shall be mounted for quiet operation.
   4. The fan shall be provided with a raised guard to prevent contact with moving parts.
   5. The outdoor unit shall have horizontal discharge airflow.

D. Coil:
   1. The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
   2. The coil shall be protected with an integral metal guard.
   3. Refrigerant flow from the outdoor unit shall be regulated by means of an electronically controlled, precision, linear expansion valve.
E. Compressor:
   1. The compressor motor shall be direct current (DC).
   2. The compressor shall be a high performance hermetic; inverter driven, variable speed, dual rotary type.
   3. The outdoor unit shall have an accumulator.
   4. The compressor will be equipped with an internal thermal overload.
   5. The outdoor unit must have the ability to operate over the full range with a maximum height difference of 50 feet and have refrigerant tubing length of 100 feet between indoor and outdoor units.
   6. There shall be no need for line size changes, traps shall not be used, and no additional refrigerant oil shall be required.
   7. The compressor shall be mounted so as to avoid the transmission of vibration.

F. Electrical:
   1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
   2. The unit shall be capable of satisfactory operation within voltage limits of 187 volts to 253 volts.
   3. The outdoor unit shall be controlled by the microprocessor located in the indoor unit and outdoor unit.
   4. The outdoor unit shall be equipped with Pulse Amplitude Modulation (PAM) compressor motor control for maximum efficiency.

2.4 ACCESSORIES

A. Thermostat: Programmable, low voltage with subbase to control compressor and evaporator fan. The Wired Remote Controller. The wired controller shall be approximately 5” x 5” in size and white in color with a light-green LCD display. There shall be a built-in weekly timer with up to 8 pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Auto/Fan/Dry mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C), and Temperature changes shall be by increments of 1°F (0.5°C). The controller shall have the capability of controlling up to a maximum of 16 systems, as a group with the same mode and set-point for all.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Hail Guard over condenser coil.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer’s standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified as detailed. Anchor units to supports with removable, cadmium-plated fasteners.

D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer’s written instructions.

3.5 DEMONSTRATION

A. Train Owner’s maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   5. Common electrical installation requirements.

1.3 DEFINITIONS

A. Retain abbreviations that remain after this Section has been edited.

B. "Furnish, Provide, Install": Whenever the words "furnish", "provide", "furnish and install," "provide and install", and/or similar phrases occur, it is the intent that the materials and equipment described be furnished, installed and connected under this Division of the Specifications, complete for operation unless specifically noted to the contrary.

C. Materials: Where a material is described in detail, listed by catalogue number or otherwise called for, it shall be the Contractor's responsibility to furnish and install the material.

D. "Shall": The use of the word "shall" conveys a mandatory condition to the contract.

E. "Section": "This section" always refers to the section in which the statement occurs.

F. "Project": "The project" includes all work in progress during the construction period.

G. Multiple Items: In describing the various items of equipment, in general, each item will be described singularly, even though there may be a multiplicity of identical or similar items.

1.4 ELECTRICAL LINES:

A. General: In general, the electrical lines to be installed under these Specifications shall be run as indicated, as specified herein, as required by particular conditions at the site, and as required to conform to the generally accepted standards as to complete the work in a neat and satisfactorily workable manner. The following is a general outline concerning the running of electrical lines and is to be excepted where the drawings or conditions at the building necessitate deviating from these standards.

B. General Construction: The Contractor shall thoroughly acquaint himself with the details of the construction and finishes before submitting his bid as no allowances will be made because of the Contractor's unfamiliarity with these details. Place all inserts in masonry walls while they are under
construction. All concealed lines shall be installed as required by the pace of the general construction to precede that general construction.

C. Working Drawings: The Contractor shall submit scale working drawings of all his apparatus and equipment which in any way varies from these Specifications and Drawings. The Architect shall check these variations from the Specifications and Drawings before the work is started. Before the work proceeds, the contractor shall correct any interference with the structural conditions.

D. Order of Precedence: Order of precedence shall be observed in laying-out the conduit in order to fit the material into the space above the ceiling and in the chases and walls. The installation shall be coordinated with the work of all other trades. The following order shall govern:

E. Items affecting the visual appearance of the inside of the building such as lighting fixtures, outlets, panelboards, etc. Coordinate all items to avoid conflicts at the site.

F. Lines requiring grade to function such as sanitary vents and storm drains.

G. Large ducts and pipes with critical clearances.

H. Conduit, water lines, and other lines whose routing is not critical and whose function bends and offsets would not impair.

I. Exceptions and Inconsistencies: Exceptions and inconsistencies in Drawings and Specifications shall be brought to the Architect's attention before the contract is signed. Otherwise, the Contractor shall be responsible for any and all changes and additions that may be necessary to accommodate his particular apparatus, material, or equipment.

J. Intent of Drawings and Specifications: The Contractor shall distinctly understand that the work described herein and shown on the accompanying drawings shall result in a finished and working job, and any item required to accomplish this intent shall be included whether specifically mentioned or not.

K. Examination of Drawings and Specifications: Each bidder shall examine the Drawings and Specifications for the General Construction. If these documents show any item requiring work under Division 26 and that work is not indicated on the respective Electrical drawings, he shall notify the Architect in sufficient time to clarify before bidding. If no notification is received, the Contractor is assumed to require no clarification, and shall install the work as indicated on the General Drawings in accordance with the Specifications.

1.5 DIMENSIONS:

A. General: Before ordering any material or doing any work, the Contractor shall verify all dimensions, including elevations, and shall be responsible for the correctness of the same. No extra charge or compensation will be allowed on account of differences between actual dimensions and measurements indicated on the drawings. Any difference that may be found shall be submitted to the Architect for consideration before proceeding with the work.

1.6 INSPECTION OF SITE:

A. General: The accompanying Drawings do not indicate completely the existing electrical installations. The bidders for the work under these sections of the Specifications shall inspect the existing installations and thoroughly acquaint themselves with conditions to be met and the work to be accomplished in removing and modifying the existing work, and in installing the new work in the present building and underground serving to and from that structure. Failure to comply with this shall not constitute grounds for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work.
1.7 ELECTRICAL WIRING:

A. Description: All electric wiring of 120 volt or higher, both for power supply, for pilot and control, for temperature control, etc. will be done under Division 26 of these Specifications. Every electrical current consuming device furnished as a part of this project, or furnished by the Owner and installed in this project, shall be completely wired under Division 26. Verification of exact location, method of connection, number and size of wires required, voltage requirements, and phase requirements is the responsibility of the Contractor under Division 26. If conflicts occur between the drawings and the actual requirements, actual requirements shall govern.

1.8 PROGRESS OF WORK:

A. General: The Contractor shall keep himself fully informed as to the progress of the work and do his work at the proper time without waiting for notification from the Architect or Owner.

1.9 MANUFACTURER'S DIRECTIONS:

A. General: All manufactured articles shall be applied, installed and handled as recommended by the manufacturer.

1.10 MATERIALS AND WORKMANSHIP:

A. Materials: All materials shall be new unless otherwise specified and of the quality specified. Materials shall be free from defects and undamaged. All materials of a type for which the Underwriters Laboratories, Inc. have established a standard shall be listed by the Underwriters Laboratories, Inc. and shall bear their label.

B. Samples: The Architect reserves the right to call for samples of any item of material offered in substitution, together with a sample of the specified material, when, in the Architect's opinion, the quality of the material and/or the appearance is involved and it is deemed that an evaluation of the two materials may be better made by visual inspection. This shall be limited to lighting fixtures, wiring devices, and similar items and shall not be applicable to major manufacturers' items of equipment.

C. Transportation: The Contractor shall be responsible for transportation of his materials to and on the job, and shall be responsible for the storage and protection of these materials and work until the final acceptance of the job.

D. Appurtenances: The Contractor shall furnish all necessary scaffolding, tackle, tools and appurtenances of all kinds, and all labor required for the safe and expeditious execution of his contract.

E. Workmanship: The workmanship shall in all respects be of the highest grade and all construction shall be done according to the best practice of the trade.

1.11 PROTECTION OF APPARATUS:

A. General: The Contractor shall at all times take such precautions as may be necessary to properly protect his new apparatus from damage. This shall include the erection of all required temporary shelters to adequately protect any apparatus stored in the open on the site, the cribbing of any apparatus above the floor of the construction, and the covering of apparatus in the uncompleted building with tarpaulins or other protective covering. Failure on the part of the Contractor to comply with the above to the entire satisfaction of the Architect will be sufficient cause for the rejection of the pieces of apparatus in question.
1.12 PERMITS, FEE, ETC.:
   A. General: The Contractor under each section of these Specifications shall arrange for a permit from the local authority. The Contractor shall pay for any inspection fees or other fees and charges required by ordinance, law, codes and these Specifications.

1.13 TESTING:
   A. General: The Contractor under each division shall at his own expense perform the various tests as specified and required by the Architect and as required by the State and local authorities. The Contractor shall furnish all fuel and materials necessary for making tests.

1.14 LAWS, CODES AND ORDINANCES:
   A. General: All work shall be executed in strict accordance with all local, state and national codes, ordinances and regulations governing the particular class of work involved, as interpreted by the inspecting authority. The Contractor shall be responsible for the final execution of the work under this heading to suit those requirements. Where these Specifications and the accompanying drawings conflict with these requirements, the Contractor shall report the matter to the Architect, shall prepare any supplemental drawings required illustrating how the work may be installed so as to comply and, on approval, make the changes at no cost to the Owner. On completion of the various portions of the work the installation shall be tested by the constituted authorities, approved and, on completion of the work, the Contractor shall obtain and deliver to the Owner a final certificate of acceptance.

1.15 COOPERATION:
   A. General: The contractor for the work under each section of these Specifications shall coordinate his work with the work described in all other sections of the Specifications to the end that, as a whole, the job shall be a finished one of its kind, and shall carry on his work in such a manner that none of the work under any section of these Specifications shall be handicapped, hindered or delayed at any time.

1.16 COORDINATION OF TRADES:
   A. General: The Contractor shall be responsible for resolving all coordination required between trades. For example, items furnished under Divisions 21, 22 and 23 which require electrical connections shall be coordinated with Division 26 for:
   1. Voltage
   2. Phase
   3. Ampacity
   4. No. and size of wires
   5. Wiring diagrams
   6. Starter size, details and location
   7. Control devices and details

   B. Ceiling Mounted Items: Items installed in/on finished ceilings shall be coordinated with the ceiling construction. The Contractor under each section shall conform to the reflected ceiling plan and shall secure details and/or samples of the ceiling materials as necessary to insure compatibility. Any device not conforming to this requirement shall be replaced by the Contractor at his expense.

   C. Electrical Items: All items specified under Divisions 26 shall be installed tight, plumb, level, square and symmetrically placed in relation to the work of other trades.
1.17 CUTTING AND PATCHING:

A. General: The Contractor for work specified under each section shall perform all structural and general construction modifications and cut all openings through either roof, walls, floors or ceilings required to install all work specified under that section or to repair any defects that appear up to the expiration of the guarantee. All of this cutting shall be done under the supervision of the Architect and the Contractor shall exercise due diligence to avoid cutting openings larger than required or in wrong locations.

B. Structural Members: No cutting shall be done to any of the structural members that would tend to lessen their strength, unless specific permission is granted by the Architect to do such cutting.

C. Patching: The Contractor for work under each section shall be responsible for the patching of all openings cut to install the work covered by that section and to repair the damage resulting from the failure of any part of the work installed hereunder.

D. Coordination: Before bidding, the Contractor shall review and coordinate the cutting and patching required with all trades.

E. Existing Surfaces: In all spaces where new work under Division 26 is installed and no other alteration or refinishing work is shown or called for, existing floors, walls and ceilings shall be restored to match existing conditions. Workmen skilled in the affected trade shall do all cutting and patching.

F. Masonry Walls: Where openings are cut through masonry walls, the Contractor under each respective section shall provide and install lintels or other structural supports to protect the remaining masonry and adequate support shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc. shall be of the size, shape, and installed as directed by the Architect.

1.18 PAINTING:

A. General: Painting for Division 26 shall be as follows:

B. If the factory finish on any apparatus or equipment is marred, it shall be touched up and then given one coat of half-flat-half-enamel, followed by a coat of machinery enamel of a color to match the original. Paint factory primed surfaces.

C. Paint all exposed conduit, boxes, cabinets, hangers and supports, and miscellaneous metal in finished spaces.

1.19 LARGE APPARATUS:

A. General: Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through windows, doorways or shafts, shall be brought to the job by the Contractor involved and placed in the space before the enclosing structure is completed.

1.20 RELOCATION OF EXISTING INSTALLATIONS:

A. General: There are portions of the existing electrical system that shall remain in use to serve the finished building in conjunction with the indicated new installations. By actual examination at the site, each bidder shall determine those portions of the remaining present installations, which must be relocated to avoid interference with the installations of new work of his particular trade and that of all other trades. All such existing installations that interfere with new installations shall be relocated by the Contractor under the Division in which the existing material normally belongs, and in a manner as directed by the Architect. For example where existing conduit and electrical equipment interferes with the installation of new work; it shall be relocated under Division 26. Failure to become familiar with the
extent of the relocation work involved shall not relieve the Contractor of responsibility and shall not be used as a basis for additional compensation.

1.21 INSTALLATION DRAWINGS:

A. General: It shall be incumbent upon the Contractor to prepare special drawings as called for elsewhere herein or as directed by the Architect to coordinate the work under each section, to illustrate changes in his work, to facilitate its concealment in finished spaces to avoid obstructions or to illustrate the adaptability of any item of equipment which he proposes to use. These drawings shall be used in the field for the actual installation of the work. Unless otherwise directed, they shall not be submitted for approval but three copies shall be provided to the Architect for his information.

1.22 ROUGH-IN AND MAKE FINAL CONNECTION FOR EQUIPMENT:

A. General: The shop drawings for all equipment are hereby made a part of these Specifications. The Contractor under each section of the Specifications shall rough-in for the exact item to be furnished on the job, whether in another section of the Specifications or by the Owner. The Contractor shall refer to all drawings and other sections of the Specifications for the scope of work involved for the new equipment, and by actual site examination determine the scope of the required equipment connections for the Owner furnished equipment.

B. Discrepancies: Should any of the equipment furnished require connections of a nature different from that shown on the drawings, report the matter to the Architect and finally connect as directed by the Architect. Minor differences in the equipment furnished and that indicated on the drawings will not constitute ground for additional payment to the Contractor.

1.23 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

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

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Metraflex Co.
   b. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

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

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

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Field Conditions: The electrical Drawings do not give exact details as to elevations of electrical lines, exact locations, etc., and do not show all the offsets, and other installation details. The Contractor shall carefully lay out his work at the site to conform to the architectural and structural conditions, to avoid all obstruction, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated, satisfactorily operating installation.

G. Locations of Electrical Devices: The electrical Drawings show diagrammatically the locations of the various electrical outlets and apparatus and the method of circuiting and controlling them. Exact locations of these outlets and apparatus shall be determined by reference to the general Drawings and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building, and in cooperation with other sections, and in all cases shall be subject to the approval of the Architect. The Architect reserves the right to make any reasonable change in location of any outlet or apparatus before installation (within 10 feet of location shown on drawings) or after installation if an obvious conflict exists, without additional cost to the Owner.

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H. Space Requirements: The Contractor shall be responsible for the proper fitting of his material and apparatus into the space. Should the particular equipment that any bidder proposes to install require other space conditions than those indicated on the drawings, he shall arrange for such space with the Architect before submitting his bid. Should changes become necessary on account of failure to comply with this clause, the Contractor shall make such necessary changes at his (the Contractor's) own expense.

I. Equipment Connections: Conduits serving outlets on items of equipment shall be run in the most appropriate manner. Where the equipment has built-in chases, the lines shall be contained therein. Where the equipment is of the open type, the lines shall be run as close as possible to the underside of the top and in a neat and inconspicuous manner.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations. Install sleeves during erection of slabs and walls.

C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

D. Cut sleeves to length for mounting flush with both surfaces of walls.

E. Extend sleeves installed in floors 2 inches above finished floor level.

F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.
B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.5 SELECTIVE ELECTRICAL DEMOLITION

A. Disconnect and remove all electrical apparatus, electrically operated equipment and devices as required in order to complete the demolition phase of the project as shown on the drawings. Where a wall or partition is shown to be removed, remove all electrical devices in that wall or partition even if the device is not shown on the drawings. Removal of a piece of electrical or electrically operated equipment includes removing all associated raceway and wiring back to source. Source is defined as the panelboard where the circuit conductors originate or the nearest junction box that contains part of the affected circuit that is not affected by demolition or construction. Reroute all electrical circuitry passing through removed walls or partitions.

B. Remove all unused or vacated panel circuit breakers and install blanking plates. Re-label directory as “Space.”

C. Re-route all conduits that will conflict with openings in walls, floors and roofs for access or for mechanical piping, ducts and new electrical conduits, or new mechanical equipment, piping, and ducts.

D. Conduits which are poured into slabs or roof decks and thus positively and effectively concealed, are the only facilities which if required to be moved, are not included in this provision, but shall be handled as a change in the Contract.

E. Reconnect all circuits in re-routed conduits to perform the existing function.

F. Existing conduit abandoned in place by the demolition phase of the project may be reused if it is concealed, meets the requirements of the drawings and is installed according to this set of specifications.

G. Provide a junction box in the ceiling as required to maintain raceway continuity where walls containing devices are removed.

H. Existing wall outlet boxes, whether retained for wiring or left empty, shall be covered by a standard-sized blank plate. Close all openings in boxes in suspended ceilings.

I. Maintain accessibility of all boxes containing wiring.

J. Restore all ceiling in existing areas, removed for installation of new work, to original condition.

K. Where conduits rising from the floor are to be abandoned, cut conduit off below floor level and patch floor to be level and of same finish. Cut into existing floors carefully only where specifically shown and patch and refinish the floor.

L. Circuit breakers installed in existing panelboards shall be of the same type and manufacture as the panelboard.
M. Prior to cutting or coring any existing structural component of the building, obtain permission of the structural engineer.

END OF SECTION 26 05 00
SECTION 26 05 01  MINOR ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to the work of this section.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Field Measurements: Verify field measurements and circuiting arrangements are as shown on Drawings.

B. Abandoned Circuits: Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Field Conditions: Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Owner and Architect/Engineer before disturbing existing installation.

D. Existing Conditions: Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Demolition: Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Utility Coordination: Coordinate utility service outages with the Utility Company and Owner.

C. Temporary Wiring: Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. General: Demolish and extend existing electrical work under provisions of the Drawings, General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections.

B. New Construction: Remove, relocate, and extend existing installations to accommodate new construction.

C. Abandoned Wiring: Remove abandoned wiring to source of supply.

D. Exposed Conduit: Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
E. Abandoned Devices: Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets, which are not removed.

F. Abandoned Panelboards: Disconnect and remove abandoned panelboards and distribution equipment.

G. Abandoned Equipment: Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Abandoned Lighting Fixtures: Disconnect and remove abandoned lighting fixtures. Remove brackets, stems, hangers, and other accessories.

I. Adjacent Construction: Repair adjacent construction and finishes damaged during demolition and extension work.

J. Existing wiring to remain active: Maintain access to existing electrical installations, which remain active. Modify installation or provide access panel as appropriate.

K. Extension of existing wiring: Extend existing installations using materials and methods compatible with existing electrical installations, as specified.

3.4 INSTALLATION

A. Relocated Materials: Install relocated materials and equipment under the provisions of Division 1 of the Specifications.

END OF SECTION 26 05 01
SECTION 26 05 19  LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Building wires and cables rated 600 V and less.
      2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS
   A. EPDM: Ethylene-propylene-diene terpolymer rubber.
   B. NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Alcan Products Corporation; Alcan Cable Division.
      3. General Cable Corporation.
      4. Senator Wire & Cable Company.
      5. Southwire Company.
   B. Copper Conductors: Comply with NEMA WC 70.
   C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN
   D. Multiconductor Cable: Comply with NEMA WC 70 for Type SO with ground wire.
2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.

B. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

C. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.

D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Concrete, Below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

F. Class 1 Control Circuits: Type THHN-THWN, in raceway.

G. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

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

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

END OF SECTION 26 05 19
SECTION 26 05 26  GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Grounding systems and equipment.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

3.4 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

END OF SECTION 26 05 26
PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Hangers and supports for electrical equipment and systems.
      2. Construction requirements for concrete bases.

1.3 DEFINITIONS
   A. EMT: Electrical metallic tubing.
   B. IMC: Intermediate metal conduit.
   C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS
   A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
   B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS
   A. Product Data: For the following:
      1. Steel slotted support systems.

1.6 QUALITY ASSURANCE
   A. Comply with NFPA 70.

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

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
   A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: All-steel springhead type.
PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

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

END OF SECTION 26 05 29
SECTION 26 05 33  
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Metal wireways and auxiliary gutters.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. LFMC: Liquidtight flexible metal conduit.
D. RNC: Rigid nonmetallic conduit.
E. GRC: Galvanized rigid steel conduit.

1.4 ACTION SUBMITTALS
A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS
A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. AFC Cable Systems, Inc.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney; a brand of EGS Electrical Group.
6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
7. Republic Conduit.
8. Robroy Industries.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. EMT: Comply with ANSI C80.3 and UL 797.

E. FMC: Comply with UL 1; zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Fittings for EMT:
      a. Material: Steel.
      b. Type: Compression with insulated throats so not to damage the insulation during wire pulling operations or set-screw.
   2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.
   3. Arnco Corporation.
   4. CANTEX Inc.
   5. CertainTeed Corp.
   7. Electri-Flex Company.
   8. Kraloy.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Niedax-Kleinhuis USA, Inc.
   11. RACO; a Hubbell company.
   12. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Cooper B-Line, Inc.
   2. Hoffman; a Pentair company.
   4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Adalet.
   2. Cooper Technologies Company; Cooper Crouse-Hinds.
   3. EGS/Appleton Electric.
   5. FSR Inc.
   6. Hoffman; a Pentair company.
   7. Hubbell Incorporated; Killark Division.
   8. Kraloy.
   10. Mono-Systems, Inc.
   12. RACO; a Hubbell Company.
   13. Robroy Industries.
   14. Spring City Electrical Manufacturing Company.
   15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
   17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, [aluminum, Type FD, with gasketed cover.]
E. Luminaire Outlet Boxes: Hand adjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

J. Gangable boxes are allowed.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:
   1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit.
   2. Concealed Conduit, Aboveground: EMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   5. Damp or Wet Locations: GRC.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression-type fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

3.2 INSTALLATION

A. Comply with NECA 1 and NEC 101 for installation requirements except where requirements on Drawings or in this article are stricter.
B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
C. Complete raceway installation before starting conductor installation.
D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
H. Support conduit within 12 inches of enclosures to which attached.
I. Stub-ups to Above Recessed Ceilings:
   1. Use EMT for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
O. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

Q. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

R. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Where otherwise required by NFPA 70.

S. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

T. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
      b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
      c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
      d. Attics: 135 deg F temperature change.
   3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
   4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
   5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

U. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement.
   1. Use LFMC in damp or wet locations.

V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Y. Locate boxes so that cover or plate will not span different building finishes.

Z. Support boxes of three gang or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Conduit installed on a roof shall be at least 12-inches above the surface of the roof.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
      b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
   5. Depth: Install top of conduit at least 30 inches below finished grade, unless otherwise indicated. Install top of conduit at least 12 inches below finished grade where conduit is installed under building slabs. Conduit shall not be installed within the structural slab.
   6. Underground Warning Tape: Comply with requirements in Division 26 Section "Identification for Electrical Systems."

3.4 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33
PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Identification for raceways.
      2. Identification of power and control cables.
      3. Identification for conductors.
      5. Warning labels and signs.
      6. Instruction signs.
      7. Equipment identification labels.
      8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS
   A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE
   A. Comply with NFPA 70.
   C. Comply with ANSI Z535.4 for safety signs and labels.
   D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION
   A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
   B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
   C. Coordinate installation of identifying devices with location of access panels and doors.
   D. Install identifying devices before installing acoustical ceilings and similar concealment.
PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2.4 FLOOR MARKING TAPE

A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2.6 WARNING LABELS AND SIGNS


B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
2.7 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16-inch-thick for signs up to 20 sq. inches and 1/8-inch-thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes, use color-coding conductor tape to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

B. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

C. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

F. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.

H. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, control panels, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Equipment: Engraved, laminated acrylic or melamine label.
      b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
      c. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
   2. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      e. Enclosed switches.
      f. Enclosed circuit breakers.
      g. Enclosed controllers.
      h. Variable-speed controllers.
      i. Push-button stations.
      j. Contactors.
      k. Dimmer panels.

END OF SECTION 26 05 53
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Photoelectric switches.
   2. Standalone daylight-harvesting dimming controls.
   3. Indoor occupancy sensors.
B. Related Requirements:
   1. Division 26 Section "Wiring Devices" for manual light switches.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring.
   2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Industries, Inc.
   2. Intermatic, Inc.
   3. NSi Industries LLC; TORK Products.
   4. Tyco Electronics; ALR Brand.
B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen second minimum, to prevent false operation.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exp

2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Basis of Design Manufacturer: Subject to compliance with requirements, provide products by Lithonia Lighting; Acuity Lighting Group, Inc.

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
   3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
   4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

2.3 INDOOR OCCUPANCY SENSORS

A. Basis of Design Manufacturer: Subject to compliance with requirements, provide products by Lithonia Lighting; Acuity Lighting Group, Inc.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
   4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
   5. Mounting:
a. Sensor: Suitable for mounting in any position on a standard outlet box.
b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch-high ceiling.

2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Basis of Design Manufacturer: Subject to compliance with requirements, provide products by Lithonia Lighting; Acuity Lighting Group, Inc.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
4. Voltage: Match the circuit voltage; dual-technology type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, Comply with requirements in Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”
B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION
   A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
   B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION
   A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
   B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
   C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
   D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION
   A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
      1. Identify controlled circuits in lighting contactors.
      2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

3.4 FIELD QUALITY CONTROL
   A. Manufacturer's Field Service: Engage a factory authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
   B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
      1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
      2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   C. Lighting control devices will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.6 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23
SECTION 26 22 13  LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
   2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
   1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. General Electric Company.
   4. Square D; Schneider Electric

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated Energy Efficiency:
   1. Exceed 10 CFR 431 (DOE 2016) efficiency levels by 20%.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70 and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
   1. One leg per phase.
   2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
   3. Grounded to enclosure.

C. Coils: Continuous windings except for taps.
   1. Coil Material: Copper.
   2. Internal Coil Connections: Brazed or pressure type.

D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

E. Enclosure: Ventilated.
   1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
   2. Wiring Compartment: Sized for conduit entry and wiring installation.
   3. Finish: Comply with NEMA 250.
      a. Finish Color: Gray weather-resistant enamel.
F. Taps for Transformers 3 kVA and Smaller: None.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

K. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
   2. Indicate value of K-factor on transformer nameplate.
   3. Unit shall comply with requirements of DOE 2016 efficiency levels, plus 20%, when tested according to NEMA TP 2 with a K-factor equal to one.

M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding the shield.

N. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

O. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
   1. 9.00 kVA and Less: 40 dBA.
   2. 9.01 to 30.00 kVA: 45 dBA.
   3. 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9.
   4. 50.01 to 150.00 kVA: 50 dBA for K-factors of 1, 4, and 9.
   5. 150.01 to 300.00 kVA: 55 dBA for K-factors of 1, 4, and 9.

2.4 IDENTIFICATION

A. Nameplates: Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located.

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

3.2 INSTALLATION

A. Install transformers level and plumb on a concrete base with elastomeric pad vibration-dampening supports.

B. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
   1. Coordinate size and location of concrete bases with actual transformer provided. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Secure transformer to concrete base according to manufacturer's written instructions.

D. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

E. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Small (up to 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
   1. Visual and Mechanical Inspection.
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, and grounding.
      c. Verify that resilient mounts are free and that any shipping brackets have been removed.
      d. Verify the unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.

f. Verify that as-left tap connections are as specified.

g. Verify the presence of surge arresters and that their ratings are as specified.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 13
SECTION 26 24 16

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Lighting and appliance branch-circuit panelboards.
   2. Suppressor protective devices.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner’s written permission.
3. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush and surface-mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   3. Finishes:
      a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   3. Isolated Ground Bus: Isolated from box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
   2. Main and Neutral Lugs: Mechanical type.
   3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.


2.2 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D-NQ/NF or comparable product by one of the following:
2. Eaton.
4. Square D; Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Provide as indicated on the drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D overcurrent devices or comparable product by one of the following:
   2. Eaton.
   4. Square D; Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents. Provide ratings as indicated on the drawings.
   2. GFCl Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
      c. Application Listing: Appropriate for application; Type HACR for feeding HVAC equipment circuits.
      d. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
      e. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.4 SUPPRESSOR PROTECTIVE DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Current Technology, Model PX3-125

B. Surge Protection Device: IEEE C62.41-compliant, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
   1. Accessories:
      a. Fabrication using bolted compression lugs for internal wiring.
      b. Integral disconnect switch.
      c. Redundant suppression circuits.
      d. Redundant replaceable modules.
e. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
f. LED indicator lights for power and protection status.
g. Audible alarm, with silencing switch, to indicate when protection has failed.
h. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
i. Four-digit, transient-event counter set to totalize transient surges.

   a. Line to Neutral: 70,000A.
   b. Line to Ground: 70,000A.
   c. Neutral to Ground: 50,000A.
4. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 or 208Y/120-V, three-phase, four-wire circuits shall be as follows:
   a. Line to Neutral: 800 V for 480Y/277, 400 V for 208Y/120.
   b. Line to Ground: 800 V for 480Y/277, 400 V for 208Y/120.
   c. Neutral to Ground: 800 V for 480Y/277, 400 V for 208Y/120.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according NEMA PB 1.1.
B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.
B. Mount top of trim 90 inches above finished floor unless otherwise indicated.
C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
D. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
E. Install filler plates in unused spaces.
F. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
G. Comply with NECA 1.
3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
   3. Test torque on each lug.

C. Tests and Inspections:
   1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION 26 24 16
SECTION 26 27 26  

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Isolated-ground receptacles.
   3. Weather-resistant receptacles.
   4. Snap switches.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.
   B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   B. Comply with NFPA 70.
   C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL5361 (single), HBL5362 (duplex).
      b. Leviton; 5361 (single), 5362 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; IG5362.
      b. Leviton; IG5362.
   2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Convenience Receptacles, with USB port, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement SD, and FL1310, LISB BC1.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; USB20AC5IWR
      b. Leviton; T-5833
   2. Description: Weather- and Tamper-resistant commercial grade with one (1) Type A and one (1) Type C, 5 amp USB ports. USB ports rated at 10,000 cycles.

2.4 GFCI RECEPTACLES

A. General Description:
   1. Straight blade, non-feed-through type.
   2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
   3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; GFR5362SG
      b. Leviton; MGFT2.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Single Pole:
         1) Hubbell; HBL1221.
         2) Leviton; 1221-2.
      b. Two Pole:
1) Hubbell; HBL1222.
2) Leviton; 1222-2.

C. Pilot-Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL1201PL for 120 and 277 V.
   b. Leviton; 1221-PLC for 120V, 1221-7PC for 277V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "on."

D. Key-Operated Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL1221L.
   b. Leviton; M1221.
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 WALL PLATES
A. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces (Stainless Steel): 0.035-inch- thick, satin-finished stainless steel.
   3. Material for Unfinished Spaces (Stainless Steel): 0.035-inch- thick, satin-finished stainless steel.

B. Wet-Location, Weatherproof Cover Plates: While-In-Use extra duty NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Hubbell; WP26E.

2.7 FINISHES
A. Device Color:
   1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise indicated or required by NFPA 70 or device listing.
   2. Isolated-Ground Receptacles: Orange.

B. Wall Plate Color: Stainless steel.

PART 3 - EXECUTION
3.1 INSTALLATION
A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.
3.3 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles (Inside Only): At each device identify the panel and circuit number to which the device is finally connected in indelible ink on the inside of the device coverplate and on the inside of the outlet box.
   2. Switches: Where more than two switches are located within 8” of each other on a wall, provide permanent labels indicating switch function.

3.4 FIELD QUALITY CONTROL

A. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   3. Using the test plug, verify that the device and its outlet box are securely mounted.
   4. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

B. Wiring device will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 27 26
SECTION 26 28 16  ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Nonfusible switches.
2. Molded-case circuit breakers (MCCBs).
3. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

D. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
2. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Interior solid-state luminaires that use LED technology.
   2. Lighting fixture supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. LED: Light-emitting diode.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBSTITUTIONS

A. Lithonia fixtures have been selected as the basis of design for this project. If other approved light fixtures are proposed (Cooper or Philips), before bid opening Contractor shall provide complete documentation clearly demonstrating their technical equivalence to the Lithonia fixtures. Contractor shall also provide, before bid opening, complete photometric calculations with foot-candle values shown on floor plans demonstrating that the proposed fixtures provide equivalent light that the Lithonia fixtures provide.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project, IES LM-79, and IES LM-80.
a. Manufacturers’ Certified Data: Photometric data certified by manufacturer’s laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers’ codes.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer’s laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Recessed Fixtures: Comply with NEMA LE 4.

C. Bulb shape complying with ANSI C79.1.

D. Rated lamp life of at least 50,000 hours.
E. Lamps dimmable from 100 percent to 0 percent of maximum light output.

F. Internal driver.

G. Nominal Operating Voltage: 120 V ac or 277 V ac.
   1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

H. Housings:
   1. Extruded-aluminum housing and heat sink.

2.2 RECESSED LINEAR

A. Minimum lumens to be equal to scheduled fixture. Minimum allowable efficacy of 85 lumens per watt.

B. Integral junction box with conduit fittings.

2.3 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:
   1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:
   1. Extruded-aluminum housing and heat sink.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
      c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.
2.5 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.


D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.
G. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

H. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 51 13
SECTION 26 56 19  
LEDC EXTERIOR LIGHTING

PART 1 - GENERAL

1.1  RELATED DOCUMENTS

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

1.2  SUMMARY

A. Section Includes:
   1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
   2. Luminaire supports.

1.3  DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color rendering index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. Lumen: Measured output of lamp and luminaire, or both.
F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4  SUBSTITUTIONS

A. Lithonia fixtures have been selected as the basis of design for this project. If other approved light fixtures are proposed (Cooper or Philips), before bid opening Contractor shall provide complete documentation clearly demonstrating their technical equivalence to the Lithonia fixtures. Contractor shall also provide, before bid opening, complete photometric calculations with foot-candle values shown on floor plans demonstrating that the proposed fixtures provide equivalent light that the Lithonia fixtures provide.

1.5  ACTION SUBMITTALS

A. Product Data: For each type of luminaire.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaire.
   4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project, IES LM-79, and IES LM-80.
      a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.9 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures, including luminaire support components.
      b. Faulty operation of luminaires and accessories.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   2. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 1598 and listed for wet location.

C. L70 lamp life of at least 50,000 hours.

D. Lamps dimmable from 100 percent to 0 percent of maximum light output.

E. Internal driver.

F. Nominal Operating Voltage: 120 V ac.

G. In-line Fusing: On the primary for each luminaire.

H. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

I. Source Limitations: Obtain luminaires from single source from a single manufacturer.

J. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Housings:
   1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
   2. Provide filter/breather for enclosed luminaires.

C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage and coating.
      c. CCT and CRI for all luminaires.

2.3 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer’s standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
   a. Color: Dark bronze.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

2.4 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, canopy ceilings, and overhang ceilings for suitable conditions where luminaires will be installed.

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

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.
B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Support luminaires without causing deflection of finished surface.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:
   1. Attached to structural members in walls.


H. Coordinate layout and installation of luminaires with other construction.

I. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 CORROSION PREVENTION

A. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 56 19
Part 1 - General

1.01 Project Summary

A. Scope: Successful bidder shall provide, install, configure, and provide warranty service for technology systems described herein. All new work shown on plans will be tied into the existing system located at each campus.

1.02 Related Documents

A. Documents: Provisions of General Conditions, Supplementary Conditions, and the sections included under Procurement & Contract Requirements are included as part of this section as though bound herein.

1.03 Related Work

A. Section 27 05 00 – Communications General Requirements
B. Section 27 05 23 – Pathways for Technology Systems
C. Section 27 05 26 – Grounding and Bonding for Technology Systems
D. Section 27 11 00 – Communications Equipment Rooms
E. Section 27 13 00 – Communications Backbone Cabling
F. Section 27 15 00 – Communications Horizontal Cabling
G. Section 27 16 00 – Communications Connecting Cords
H. Section 27 18 00 – Communications Labeling and Identification
I. Section 27 40 00 – AV/Multimedia General Requirements
J. Section 27 41 00 – Audio Visual Systems
K. Section 27 51 00 – Distributed Communications Systems
L. Section 27 60 00 – Physical Security General Requirements
M. Section 27 62 00 – Electronic Access Control System
N. Section 27 64 00 – Video Surveillance System
O. Section 27 66 00 – Intrusion Detection System

1.04 Definitions

A. Approved or Approval: Where approval is called for, only persons with the authorized authority may grant approval. Owner reserves all rights to govern over and grant approval and will appoint authority of agents acting on their behalf.
B. As Required: Contractor shall provide the quantity of said item that is necessary. Owner and Consultant reserve the right to make the final determination of necessary quantities to provide for a complete system.

C. Basis of Design: The documentation of the concepts, calculations, decisions, and product selections used to meet the Owner’s project requirements. These Consultant produced documents are not shop drawings. Product selections depict minimum functionality and overall quality and are open to substitution requests.

D. Consultant: True North Consulting Group

E. Contractor: The qualified party responsible to provide all items and perform services as described within these documents. The Contractor referred to within a specific specification section shall be the successful qualified party contracted to perform and complete that work.

F. Documents: The complete package of Bid and Contract Requirements, General Technology Requirements, related Division 27 sections, drawings, schedules, and addenda that make up this Request for Bid.

G. End-User: Individual(s) who will ultimately operate the completed system.

H. ETR: Existing to Remain. Item is to remain in current location and maintain current functionality.

I. Furnish: To supply and deliver to project site, ready for installation.

J. Install: To place in a position of service or use.

K. NIC: Not in Contract. Item will be the responsibility of others.

L. Notice to Proceed: Formal communication from Owner to Contractor stating the date the Contractor can begin work subject to the conditions of the contract. The performance time of the contract starts from the Notice to Proceed date.

M. OFCI: Owner Furnished Contractor Installed. Item will be provided by Owner and shall be installed by Contractor.

N. OFE: Owner Furnished Equipment. Item will be provided and integrated by Owner.

O. OFOI: Owner Furnished Owner Installed. Item will be provided and installed by Owner.

P. Owner: The party named in the Procurement and Contract Requirements as the advertising party.

Q. Provide: To furnish and install, complete and ready for intended use.

R. Substantial Completion: The stage in the progress of installation when the systems described herein are sufficiently complete, in accordance with the Contract Documents, so that the Owner can utilize such systems for their complete intended use.

S. Turnkey: Of or involving the provision of a complete product or service that is ready for immediate use.

T. Work: The provision of products and/or services to meet the requirements specified in these documents.
1.05 Reference Standards and Codes

A. Standards and other procedures referenced by this bid package are as follows:

1. ADA – Americans with Disabilities Act of 2010
   www.ada.gov/2010ADAstandards_index.htm

2. AIA – American Institute of Architects
   www.aia.org

3. ANSI – American National Standards Institute
   www.ansi.org

4. ASTM – American Society of Testing and Materials
   www.astm.org

   (RCDD Standards)
   www.bicsi.org

6. CFR – Code of Federal Regulations
   (Available from the Government Printing Office)
   (Material is usually first published in the Federal Register)

7. U.S. Copyright Law, December 2011
   www.copyright.gov/title17

8. ECIA – Electronic Components Industry Association
   ESC – EIA Standards Council
   www.eciaonline.org

9. IACS – International Annealed Copper Standard
   www.ndt-ed.org/GeneralResources/IACS/IACS.htm

10. IEC – International Electrotechnical Commission
    www.iec.ch

11. IEEE – Institute of Electrical and Electronics Engineers
    standards.ieee.org

12. ISO – International Organization for Standardization
    www.iso.org

    www.itu.int

14. NEC – National Electrical Code (NFPA 70)
    maintained by NFPA – National Fire Protection Association
    www.nfpa.org

15. NECA – National Electrical Contractors Association
    www.necanet.org

16. NEMA – National Electrical Manufacturers’ Association
    www.nema.org
17. OSHA – Occupational Safety and Health Administration
   (U.S. Department of Labor, OSHA)
   www.osha.gov

18. TIA – Telecommunications Industry Association
   www.tiaonline.org/standards

19. UL – Underwriters’ Laboratories
   www.ul.com

B. Standards: Referenced standards and/or procedures shall be binding on the Contractor and work shall be judged against such standards and procedures unless otherwise stated in writing.

C. Local/State Codes: Contractor shall comply with all local and state code requirements as determined by the authority having jurisdiction (AHJ).

D. Owner Standards: Contractor shall obtain and abide by all published Owner standards as they pertain to the work described herein.

E. Contractor shall use the latest versions of all standards and codes unless otherwise directed by the authority having jurisdiction (AHJ) or expressly noted herein.

1.06 Qualifications

A. Refer to related sections for specific requirements.

1.07 Permits and Inspections

A. Responsibility: Obtain permits and inspections required for the work. Contractor is responsible for all permit and inspection costs.

B. Performance: Perform tests required herein, or as may be reasonably required to demonstrate conformance with the specifications or with the requirements of any legal authority having jurisdiction.

C. Review: Obtain approvals from authorities responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with all requirements of reference codes indicated herein and required by the appropriate jurisdiction. Make corrections, changes or additions as required and deliver certificates of acceptance, operation, and/or compliance with the Operation and Maintenance Manuals described herein.

1.08 Drawings and Basis of Design

A. General: Work, equipment, or material delineated on any drawing in this package is expected to be provided by Contractor unless noted otherwise.

B. Interpretation: Work shall be installed in accordance with the basis of design diagrammatically expressed on the drawings and described in the written specifications and equipment schedule(s). Contractor shall not make limiting interpretation that provides for incomplete work or a non-functioning system.

1.09 Product Substitution Procedures

A. Requests for Substitutions: Should the Contractor request a change in the material that is to be supplied, from that which was specified in the contract, the Contractor shall provide the Owner and the Consultant with a written request for said change.
B. Substitutions for Non-specified Products: Where no product specification is provided, Contractor may use manufacturer’s specification for the identified product as a guide for suggesting appropriate substitutions.

C. Requirements: The Request for Substitution shall include:
   1. Reason for substitution.
   2. Material data sheets for both the proposed item(s) and the item(s) to be replaced.
   3. Any cost impact to the Owner.

D. Changes: Proposed changes to Contract Documents shall be clearly identified in the pre-construction submittals.

E. Approval: The Owner may approve or deny any Requests for Substitution. The Owner reserves the right to govern over and proclaim whether proposed products are equal to the specifications. The Contractor shall not procure any substitute materials until the Owner has approved and signed the Request for Substitution and passed copies to the Contractor and the Consultant. Any procurement or work performed prior to this approval is at the Contractor’s own risk.

F. Deviation: Products provided or installed that deviate from the products specified in make, model, color, or other significant characteristic (i.e., non-approved substitutions) shall be removed and replaced with specified products at no additional expense to Owner.

1.10 Software

A. Versions: Consultant used the following software versions for this project:
   1. Autodesk Revit MEP 2020 (floor plans)
   2. Autodesk AutoCAD MEP 2020 (detail sheets)

1.11 Submittal Conditions

A. The Contractor shall not consider the Consultant or Owner’s review of submittals to be exhaustive or complete in every detail. Approval of shop drawings or submittals including substitutions indicates only the acceptance of the Contractor’s apparent intent to comply with general design or method of construction and quality as specified. The finished product shall meet functional requirements, operations, arrangements, and quantities and comply with the contract documents unless specifically approved otherwise.

B. The Contractor shall be held responsible for delivery of systems as specified. Any errors or omissions in the submittals shall not relieve Contractor of responsibility to deliver complete systems as specified.

1.12 Pre-Construction Procedures

A. Pre-Construction Submittal Meeting: Contractor shall schedule web conference (WebEx or similar) with Consultant to review basis of design and submittal expectations.

B. Prior to Work: Pre-construction submittals shall be provided to Consultant with appropriate promptness as to cause no delay to the work.
C. Project Timeline: Project timeline will not be altered due to lateness of submittals. Contractor is bound to deliver a timely, complete, and finished project as stipulated in their contract and specified herein.

D. Format and Distribution: Contractor shall provide one (1) electronic copy in PDF format to Consultant of all pre-construction submittals. The Contractor shall provide hard copies sets as required up to five (5) sets.

E. Provision: Contractor shall submit pre-construction submittals including any corrections or additions to Consultant prior to the procurement of equipment or commencement of work.

F. Review: Pre-construction submittals shall be received and formally approved by Consultant prior to the procurement of material or the commencement of work. Any procurement or work performed prior to this approval is at Contractor's own risk.

G. Failure to Provide: The failure of Contractor to provide pre-construction submittals as required herein may result in the withholding of payment for work and/or the cancellation of the contract.

Pre-Construction Submittals

A. Pre-construction submittals are intended to document the details of installation. Exact copies of original drawings and specifications are not acceptable as pre-construction submittal drawings. Consultant schematic diagrams describe the basis of design as defined herein.

B. Contractor shall provide to Consultant the following pre-construction submittals for approval in addition to specific requirements identified in subsequent sections.

1. Qualifications: Shall include documentation of all required qualifications.

2. Shop Drawings:
   a. Title: Each drawing shall have a descriptive title and all subparts of each drawing shall have unique identifiers.
   b. Floor Plans: Shall include device locations, Contractor provided furniture and installation notes.
   c. System Drawings: Shall include functional diagrams for each system detailing system flow including all equipment, routing, inputs/outputs, wiring signal type, cable identification detail, connectors, adapters, intra/inter-rack power distribution, installation notes and any other information required to convey the complete turnkey system design.
   d. Equipment Rack and Cabinet Elevations: Shall include placement of all mounted equipment.
   e. Structurally Mounted Elements: Shall include both plan view of placement as well as a detail of structural mounting techniques to be used.
   f. Furniture: Shall include all Contractor provided furniture showing dimensional drawings, cable management and finishes with samples for Owner approval.

3. Product Data:
   a. Equipment Schedules: Shall include manufacturers, part numbers, quantities and unit pricing.
b. Product Cut Sheets: Shall identify (highlight, arrow, etc.) actual part numbers to be utilized including but not limited to equipment, mounting hardware, cabling, connectors, software and power distribution equipment.

4. Manufacturer’s Recommendations:
   a. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, copies of these recommendations shall be provided prior to installation. Installation of the items will not be allowed to proceed until the recommendations are received and approved.

1.14 Pre-installation Procedures
   A. Refer to individual sections for additional information.

1.15 Construction Progress Procedures
   A. Meeting Attendance: Contractor is required to attend job progress meetings in accordance with requirements set by Owner or Consultant.

   B. Additional Coordination: Contractor shall request additional job construction coordination meetings it deems to be necessary to ensure coordination of their responsibilities with other parties.

   C. Progress Inspection: Consultant may perform periodic progress inspections. At Consultant’s request, Contractor shall make Project Manager and/or Lead Technician available.

   D. Test Plan: Ten (10) business days prior to the proposed Contractor test date, Contractor shall provide a test plan defining the tests required.

      1. The test plan shall be approved by Consultant prior to any testing.

1.16 Construction Progress Submittals
   A. Completion: Contractor shall complete and submit via email all construction progress documentation in PDF format as requested by Owner and Consultant.

   B. Contractor shall provide to Consultant the following construction progress submittals in addition to specific requirements identified in subsequent sections.

      1. Weekly Report: Weekly written report to be submitted to Consultant through appropriate project channels in PDF format outlining progress from previous week, plans for progress in the current week, and any coordination issues that may require Consultant or Owner attention.

      2. Test Plan: Shall ensure the system meets Owner operational and performance specifications and include the following:

         a. Identification of the capabilities and functions to be tested.

         b. Detailed instructions for the setup and execution of each test.

         c. Procedures for evaluation and documentation of the results.

   C. Failure to Complete: Failure to complete requested construction progress documentation may result in the withholding of payment by Owner.
Closeout Procedures

A. Notification: Contractor shall provide written notification to Consultant and Owner when Contractor is satisfied that the work has reached Substantial Completion and is ready for inspection.

B. Pre-Inspection Submittals: Contractor shall submit an electronic copy of all closeout submittals to Consultant in accordance with the requirements found in these documents no less than ten (10) business days prior to the scheduled Final Inspection.

1. Test Results
2. As-built drawings (full-size sheets)
3. Operation and Maintenance Manuals
4. End User Software
5. Photos that demonstrate complete system installation.

C. Punch List: Work or materials found to be incomplete, of unsatisfactory quality, failing to meet the specifications in these documents, and/or unacceptable to Consultant or Owner shall be documented by Consultant and provided to Contractor to rectify at no additional cost. Contractor shall provide written notification to Consultant and Owner when all punch list items have been completed.

D. Final Inspection: At Consultant’s request, Contractor shall make Project Manager and/or Lead Technician available.

E. Re-Inspection: If more than one (1) re-inspection is necessary, the costs of the additional travel, time, and expenses of Owner and Consultant may be deducted by Owner from the contract amount due to the Contractor.

F. Punch List Approval: Once all punch list items are complete, the Contractor shall return an initialed punch list to the Consultant and Owner for verification. Punch list shall be considered complete only after having been signed by Owner and Consultant.

G. Closeout Submittals: Upon approval of closeout submittals and prior to final acceptance, Contractor shall provide three (3) electronic copies to Owner and Consultant in format(s) noted below.

1. Record Drawings – AutoCAD 2010 editable .dwg format AND PDF.
2. Operation and Maintenance Manuals – CD OR DVD.
3. End User Software – CD OR DVD.
4. Documentation of testing and system certification.

H. Closeout Submittal Format and Distribution: Upon approval of closeout submittals and prior to final acceptance, Contractor shall provide a total of three (3) bound hard copies and one (1) digital copy with labeled dividers of all record drawings (full-size sheets) and operation and maintenance manuals, three (3) copies to Owner and one (1) digital copy to Consultant. Title on front and spine of binder shall be “Operation and Maintenance Manual – [Project Name]”. The following additional items shall be identified on the binder cover:

1. Client Name
2. Contractor Name and Contact Information

3. Consultant Name and Contact Information

4. Date

I. All documentation prepared by the Contractor, including hard copy and electronic forms, shall become the property of the Owner.

J. Payment Authorization: Final payment will be authorized only after all closeout procedures and requirements have been followed and fulfilled by Contractor and approved in writing by Owner and Consultant, including punch list(s) and/or re-inspection(s) and delivery of closeout deliverables.

1.18 Closeout Submittals

A. Closeout submittals are intended to document the details of the final installation that substantially conforms to the construction documents and functions as intended to meet the Owner’s needs.

B. Contractor shall provide to Consultant the following closeout submittals for approval in addition to specific requirements identified in subsequent sections.

1. As-built drawings: As-built drawings are prepared by the Contractor. They show, in red ink, on-site changes to the Consultant-approved pre-construction submittal documents. As-built drawings shall be submitted to Consultant for approval prior to submitting record drawings and include:

   a. Changes made by Addenda, Change Orders, Requests for Information (RFIs), Architect’s Supplemental Instruction (ASIs), or Requests for Proposal (RFPs) in addition to any other changes to the original documents.

   b. Actual device locations, conduit routing, wiring and relationships as they were constructed.

   c. Nomenclature showing as-built wire designations and colors.

   d. Room numbers coinciding with Owner space planning numbering.

2. Record drawings: Record drawings are the final drawings prepared by the Contractor and incorporate all as-built drawing changes previously approved by Consultant. Record drawings should be electronically produced without any handwritten, red ink, or clouded changes.

3. Operation and Maintenance Manuals: Notwithstanding requirements specified elsewhere, submit one (1) copy of each of the following per binder:

   a. A final Bill of Materials for each system.

   b. A Microsoft Excel (.xlsx format) spreadsheet for each device that resides on the network provide the following:

      i. IP Address

      ii. MAC Address

      iii. Serial Number

      iv. Manufacturer

080320
v. Model Number  
vi. Device Username  
vii. Device Password  
viii. Telecom Closet or Rack Location  
ix. Patch Panel Port Number  
x. Switch Port Number  
xi. Any other relevant information as requested by Owner  
c. Manufacturers Instruction Manuals: Specification sheets, operation manuals and service sheets published by the manufacturers of the components, devices and equipment provided.  
d. Information for testing, repair, troubleshooting, assembly, disassembly, and recommended maintenance intervals.  
e. Replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.  
f. Performance, Test, and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.  
g. Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers’ Warranty Registration papers as described herein.  
h. Sufficient information, (detailed schematics of subsystems, assemblies, and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.  
i. Any other items defined herein.  

4. Local Reference Diagrams: Within each equipment rack, enclosure, or cabinet, the Contractor shall place a functional diagram of the system(s) in a clear plastic sleeve secured to the equipment rack, cabinet, or enclosure.  

5. Intellectual Property: Provide all required items and written release as described herein.  

6. Training Program: Proposed training materials and program outline.  

7. Spare Parts and Remote Controls: Contractor shall submit record of Owner sign-off of turnover of spare parts and remote controls.  

1.19 Project Management  

A. Project Manager: Contractor shall appoint a Project Manager who will be the main point of contact for Owner and Consultant regarding the project.  

B. Responsibility: Project Manager is responsible for the following:  

1. Successfully completing the contract in a timely manner.  

2. Overseeing work and performance of all employees and Subcontractors who have been hired by Contractor, and ensuring compliance with specification.  

3. Completing and submitting required documentation.
4. Attending project coordination meetings as required by Owner, Consultant, and Contractor. Contractor is responsible for taking minutes of these meetings and distributing copies to all participants in a timely manner.

5. Coordinating with Owner, Consultant, Architect, General Contractor, and other Contractors involved in the project to ensure smooth flow of work and on-time project completion.

6. Providing a written weekly progress update to the Owner and Consultant in a PDF format emailed to the project team.

7. Reporting all unexpected conditions and problems that may result in delay or expense to Owner and Consultant immediately upon discovery.

C. Change of Project Manager: If Contractor seeks to change Project Manager during the course of the Project, such change is subject to prior written approval from Owner.

D. The Owner reserves the right to request a change of project manager at any time for any reason.

1.20 Examination of Existing Conditions

A. Examination: Contractor shall examine the facility and construction documents to the extent necessary to plan for efficient installation strategies prior to the delivery of materials to the site or the commencement of work. Other documents (Architectural Drawings, hardware schedules…) may be made available upon request. Failure to adequately complete the examination shall not result in change order requests.

B. Acceptance of Conditions: Commencement of work by Contractor shall indicate acceptance of existing conditions, unless a written notice of exceptions has been provided to Owner prior to commencement.

C. Observation: If Contractor observes—during preliminary examinations or subsequent work—existing violations of fire stopping, electrical wiring, grounding, or other safety- or code-related issues, Contractor shall report these to Owner in a timely manner.

D. Pre-Existing Damage: If Contractor observes damage to finished surfaces before they begin installation in any area, Contractor shall document by taking digital photos of the damaged area(s) and immediately notify Construction Manager and Consultant via email with attached photos.

E. Damage during Installation: Any damage caused by, or reasonably believed by the Construction Manager to be caused by the Contractor shall result in back-charges for said damages. Repairs shall match preexisting color and finish of walls, floors, and ceilings. Any Contractor damaged ceiling tiles, floor, and carpet shall be replaced to match color, size, style, and texture.

1.21 Contract Modification Procedures

A. Changes: Changes to the contract may be initiated by Owner, Consultant or Contractor.

B. Request for Information (RFI): If a change originates with Contractor, the Contractor shall submit an RFI for Consultant review. If it is deemed a change is necessary, the Consultant shall issue a PR to address the change.

C. Proposal Request (PR): If a change originates with Owner or Consultant, Consultant shall issue a Proposal Request to Contractor.
D. Change Proposal (CP): If a change originates with Contractor, or if Contractor receives a Proposal Request from Consultant, Contractor shall submit a Change Proposal to Consultant to review.

   1. References: A Change Proposal shall reference the work to be performed, and shall include the cost change to the Project (if any) and the time change to the scheduled completion (if any).

   2. Additional Information: Consultant may request additional information to be supplied with the Change Proposal for consideration.

   3. Acceptance: Owner reserves the right to accept or reject Change Proposals.

E. Change Order: A Change Order is a modification of the contract.

   1. If a Change Proposal is approved, Owner will issue a Change Order that references PR and/or CP. Change Order is not valid until it has been signed by Owner.

   2. Work performed or equipment supplied outside of contract without a valid Change Order is done at Contractor's own risk.

1.22 Product Storage and Handling Requirements

A. Storage: Contractor shall provide secure material storage. If Contractor chooses to store cabling or equipment at project site, that Contractor shall receive written approval from GC or Owner to identify acceptable location. All equipment provided by the Contractor remains the responsibility of that Contractor until Owner has beneficial use of the equipment.

B. Protection: Contractor shall take all necessary precautions to protect materials from the following:

   1. Theft
   2. Vandalism/Tampering
   3. Dents
   4. Scratches
   5. Dust
   6. Temperature
   7. Weather
   8. Cutting
   9. Paint
   10. Other hazardous conditions

C. Replacement: Contractor shall replace any damaged or lost material as required by Owner or Consultant.

D. Installed Materials: Installed materials remain the responsibility of the Contractor until Acceptance. Contractor shall take necessary precautions to ensure the safety and security of installed materials.
1.23 Interference with the Facility

A. Transportation and storage of materials at the facility, work involving the facility, and other matters affecting the habitual use by the Owner of the Owner’s buildings, shall be conducted to minimize interference, and at times and in a manner acceptable to the Owner.

1.24 On-Site Conduct

A. Conduct: Any demonstration of rudeness, use of profanity, or lack of respect by Contractor Personnel to a building tenant will be cause for immediate removal from the premises, and such Personnel will not be allowed to return. Contractor and Contractor’s Personnel are to remain in project area.

B. Vandalism: Graffiti or vandalism will not be tolerated. Any Contractor/Personnel caught in the act shall be immediately removed from the premises and will not be allowed to return.

C. Hazardous Conditions: No one shall be allowed to endanger the building, its premises, or its occupants in any manner whatsoever. In the event that a situation occurs which threatens the building or its occupants in any manner, Contractor, Contractor Personnel, Subcontractor, etc. shall take immediate steps to correct the hazardous condition. In the event that Contractor’s Personnel fail to correct hazardous condition, Owner reserves the right to immediately take steps to correct the situation at Contractor’s expense.

1.25 Safeguards and Protection

A. Barriers: Provide and maintain suitable barriers, guards, fences and signs where necessary to accommodate the safety of others relative to and/or for the protection of this work.

B. Regulations: Comply with OSHA, Federal, State, Local, and Owner regulations and standards pursuant to this work.

C. Protection: Protect all materials and equipment to prevent the entry or adhesion of any and all foreign material. If necessary, cover equipment with temporary protective material suitable for this purpose.

D. Finishing: Check, clean and remove defects, scratches, fingerprints and smudges if necessary from all equipment and devices immediately prior to Acceptance of the Installation.

E. Damage: Replace all damaged or defective material or work at no additional cost prior to Final Acceptance.

F. Documentation: Provide written description of accidents by workers, staff, and general public of any incident occurring on the project. Report incident in writing to Owner’s representative immediately and to the Project Manager for follow up.

1.26 Owner-Furnished Products

A. Delivery: Owner is responsible for delivery of Owner-furnished products to the project site, unless otherwise specified in this document.

B. Placement: Contractor is responsible for locating, inspecting, and moving Owner-furnished products to their final installation position.

C. Inspection: Contractor shall report any damage, discrepancies in quantity, type, or function to Owner and Consultant immediately upon discovery.
D. Warranty: Contractor assumes no responsibility for any material warranty for Owner-furnished products. Contractor shall be responsible for integrating, cabling, and installing Owner-furnished products under the same warranty conditions as other products furnished by Contractor.

1.27 Quality Assurance

A. Assurance: It is the intent of these specifications to describe and provide for a complete, professional, and reliable installation.

B. Qualifications: Contractor employees who are engaged in installation shall be properly trained in the tasks they are expected to perform.

C. Acceptability: Owner shall determine the acceptability of work.

D. Regulatory Requirements: Contractor shall comply with code requirements that apply to the work being performed.

E. Certifications: Where manufacturer certifications are required for warranty or for authorized resale, installation personnel shall have received such certification prior to the start of installation of those manufacturers’ materials.

1.28 Quality Control

A. Installation: During installation period, when connections are made to the Owner’s existing infrastructure, Contractor shall use care to ensure that such connections will not have a negative impact which could reduce or hamper existing systems.

1.29 Owner’s Right to Use Equipment

A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

1.30 Intellectual Property Ownership

A. All intellectual property shall remain in escrow for an unlimited period of time. All supporting documentation including but not limited to: software, firmware, programming, uncompiled source code, graphic files, diagrams, written and electronic files, including all latest versions of the documentation and software necessary to edit and adapt the system(s), shall be provided to the Owner on a CD or DVD for all spaces and all systems. The integrator and/or programmer shall also maintain a current live copy incorporating all system modifications to be provided at the Owner’s request and for system restoration upon a failure.

B. A written release shall be given by the Contractor and all other required parties for all programming and configuration done by the Contractor and/or Subcontractors. This release will acknowledge the Owner’s ownership and right to modify the intellectual property directly, or to have the intellectual property modified by any party of the Owner’s choosing.

Part 2 - Products

2.01 Basic Equipment and Materials Requirements

A. Standards: Equipment and materials used to accomplish the goals of this project shall meet standards for good engineering practice as defined within this document.
B. **Quality:** Products specified in these documents are intended to establish a baseline or operational, functional, and performance-based standards that all proposed products shall meet or exceed by functionality and quality.

### 2.02 Factory-Assembled Products

A. **Manufacturer:** Reference to specific equipment manufacturers does not imply that all products produced by that manufacturer meet the specification requirements.

B. **Age of Equipment:** Equipment shall be new and unused with full manufacturer’s warranties. Contractor shall supplement such warranties as required by the specification. Contractor shall immediately notify Consultant of any product that will be or is expected to be discontinued by the end of the project for resolution.

C. **No Modification:** Where a product is available from a factory/manufacturer to meet the needs as outlined, that product shall be used without modification to ensure the full factory warranty is maintained.

D. **Like Materials:** Like materials used shall be of the same manufacturer, model, and quality unless otherwise specified.

E. **Software/Firmware:** No software or firmware is to be used unless specifically authorized by Owner or its appointed representative.

### 2.03 Racks, Cabinets, Hardware

A. **Equipment Racks and Cabinets:** Provide racks and cabinets as specified herein and/or described in accompanying documents, appendices, or drawings. Verify that any existing racks and/or cabinets provided by others are complete, bringing any discrepancies to the attention of Owner and Consultant prior to beginning the installation.

B. **Shelves and Mounts:** Contractor shall supply necessary mounting hardware to install rack-mounted equipment. Mounting hardware shall be a product of the manufacturer of the equipment to be mounted, or manufacturer of the rack system, or approved by either for use with their product. Provide supporting channels, shelves, rack mounts, and/or rack ears as recommended by equipment manufacturers.

C. **Screws and Washers:** Contractor shall provide screw head types appropriate to the level of security required for the equipment and racking. Screws shall include polyethylene or nylon washer.

1. **Public Access Areas:** Star post or square post security screws shall be used for hardware and equipment mounted in equipment racks and consoles in areas that are accessible to the public.

2. **Restricted Access Areas:** Philips head screws may be used where a secure room entrance or locked rack/console door prevents public access.

### 2.04 Power Devices

A. **Power Strips:** Unless otherwise specified, power strips shall be UL listed, surface mounted, and rated for 20 amp continuous electronic loads. Outlets shall be 125 volt, 20 amp, three-wire, grounded, and NEMA 5-20R compliant. Cords shall be 12/3 SJT with molded plug.

B. **Power Distribution Panels:** Unless otherwise specified, power distribution panels shall be UL listed, rack mounted, rated for 20 amp continuous electronic loads, with switch and pilot light. Up to eight outlets shall be mounted to the back, each rated 125 volt, 20 amp, three-wire,
grounded, and NEMA 5-20R compliant. Switch and pilot shall be mounted to the front. Cords shall be 12/3 SJT with molded plug.

C. Contractor shall provide acceptable power distribution units as required in order to provide sufficient outlet connectivity for Contractor-furnished and Owner-furnished equipment indicated on drawings and equipment schedules, plus up to 15% additional capacity for future growth. This may be in addition to any power distribution equipment indicated on equipment schedules.

2.05 Cable and Connectors

A. Cable: Cable shall be selected and applied in a manner defined by signal type, consistent with best industry practices. Highest quality products shall be used with attention given to transmission characteristics, termination methods, resistive and complex impedance at operating frequencies, and insulating material characteristics. Where required by the NEC, substitutions of air handling plenum cable shall exactly match the normally applied product and shall meet the standards of UL Standard #900 and the NEC Articles 800 and 820.

B. Connectors: Highest quality products shall be used with attention given to transmission characteristics, termination methods, resistive and complex impedance at operating frequencies, and insulating material characteristics. Strain reliefs and cable clamps shall be sized for the connector and the cable.

C. Color: Cable and connector color shall be coordinated with Consultant to maintain consistency with cable and connector color schemes used by other trades.

2.06 Cable Management

A. Plastic Cable Ties: Single use white nylon plastic cable ties, appropriate screw fittings, or mounting clips may be used for AC power cable management within racks and enclosures. Plastic/nylon cable ties shall not be used for signal and DC cables.

B. Velcro Cable Ties: Velcro straps shall be used for all signal and DC cables. Velcro straps shall be black, with no logo or decoration, except as authorized by Consultant.

2.07 Ancillary Hardware

A. General: Contractor shall provide ancillary and required accessory items necessary to provide a complete and fully functional system to Owner.

B. Interpretation: Exclusion of or limitation in the language used in the drawings or specifications shall not be interpreted as meaning that ancillary or accessory items of work or equipment necessary to complete or make the installed system fully functional can be omitted.

2.08 Grounding Hardware

A. Refer to Section 27 05 26 for specific Grounding and Bonding requirements.

B. Provide data/telecommunication grounding systems indicated in the project drawings and specifications. Products shall include, but are not limited to, cables/wires, connectors, terminals, compression lugs, grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, ANSI/TIA and established industry standards for applications indicated.
2.09 Fire Stopping Materials

A. All penetrations of walls shall be approved by the General Contractor before any penetrations are made. Should the Contractor find it necessary to penetrate any walls extending to the slab, it will be the responsibility of that Contractor to provide satisfactory sleeving and fire caulking both inside and outside of that sleeving. If existing sleeving is to be utilized, it will be the responsibility of the Contractor to fire caulk inside the sleeving.

B. The Contractor is responsible for adhering to the following standards:

1. Conduit penetrations through fire-rated or smoke walls: Completely seal around the conduit penetration with Hilti FS 601 fire-rated sealant or equivalent by Tremco, 3M, or equal.

2. Conduit sleeves through fire-rated or smoke wall: Completely seal around the conduit penetration with Hilti FS 601 fire-rated sealant or equivalent by Tremco, 3M, or equal. Completely seal inner opening of the conduit sleeve with fire wool packing and Hilti FS 611A intumescent firestop sealant.

3. Cable bundles through fire-rated or smoke walls (without sleeves): Completely seal openings with Hilti FS 611A intumescent firestop sealant or equivalent by Tremco, 3M, or equal.

4. Cable tray penetrations through fire-rated or smoke walls: Completely seal openings with Hilti FS 635 (trowelable type), or equivalent by Tremco, 3M, or equal.

C. A submitted response to this specification assumes that all firestopping will be provided as specified. The firestop manufacturer’s specifications and instructions shall be submitted with the final documentation.

2.10 Compatibility of Related Equipment

A. Existing Equipment: Equipment and systems specified in these documents shall be assumed to be compatible with the systems already installed at Owner site(s) and as identified in this document as related to this project.

B. Installed Equipment: Specified equipment and systems shall be compatible with all other equipment and systems as offered by Contractor, thus placing the responsibility on Contractor to ensure proper interaction.

2.11 Licenses

A. Any and all licenses required for system functionality shall be provided.

2.12 Spare Parts

A. Suggested List: Contractor is requested to submit a list of suggested spare parts with an offered price, allowing Owner to select appropriate parts.

B. Means of Obtainment: Contractor shall state where spare parts can be obtained after the installation.

2.13 Maintenance Manuals

A. Contractor shall produce a maintenance manual showing interconnection of equipment and any special procedures necessary for proper operation and maintenance of the systems.
Part 3 - Execution

3.01 General

A. Contractor shall provide, furnish, deliver, transport, erect, install, connect and configure all of the material and equipment described herein or depicted on any bid package document or drawing, as required for a turnkey solution.

3.02 Coordination

A. General: Contractor shall cooperate with other Contractors for proper provisioning, anchorage, placement, and execution of all work. Interference between the work of various Contractors shall be resolved before installation. In the event of conflict on space requirements or location of devices, refer the matter to Owner and Consultant for decision.

B. Related Work: References to the following related work do not limit or release Contractor from the responsibility of coordination with other trades or from having the necessary knowledge of other non-referenced work.

1. Work by General Contractor.
2. Work by other Technology Contractors.
3. Work by Electrical Contractor, including electrical rough-ins and surface-mounted raceway.

C. Delays: Contractor shall coordinate with all other trades to avoid causing delays in the installation schedule.

D. AC Power: Contractor shall coordinate with General Contractor its requirements for proper AC power to service all equipment installed by Contractor.

E. Low Voltage Sleeving: Contractor shall provide openings through walls as necessary, with sleeving and fire-stopping materials installed in a professional manner to meet local and national codes.

F. Grounding and Bonding: Contractor shall coordinate with General Contractor its requirements for proper grounding and bonding to their equipment.

G. Surface-Mounted Raceway Coordination

1. General and Electrical Contractors: Contractor shall coordinate with General Contractor and Electrical Contractor the installation of surface-mounted-raceway where not provided but made necessary by non-penetrable wall.
2. Verification: Contractor shall field verify and coordinate the proposed use of surface-mounted raceway at any location with Consultant and Owner.

3.03 Basic Execution Requirements

A. General: Contractor is responsible for following industry standards of good practice for telecommunications and networking equipment.

B. Aesthetic Factors: With the installation of equipment and cables, consideration shall be given not only to operational efficiency but also to overall aesthetic factors. Contractor shall redo, at no cost to Owner, any work deemed by Owner to appear sloppy, hastily done, or unprofessional. Owner shall make final decision over whether work shall be redone.
C. Manufacturers’ Recommendations: Manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by the manufacturers or as indicated in their published literature unless otherwise noted herein.

D. Protection of Work Area: Work shall be properly protected during construction: including shielding soft or fragile materials, protecting against dust and dirt, protecting and supporting cable ends off of the floor and from other traffic, protecting floor box lids, and temporarily plugging open conduits during construction. Upon completion, installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of work shall be removed from the premises.

E. Protection of Cable and Equipment: Contractor shall make appropriate preparations to protect all cabling and equipment from foreign material. Foreign material is defined as any substance or material that would void the manufacturer’s performance warranty, impact ratings (UL, Plenum, etc.), or cover up markings needed for inspection. Foreign material includes, but is not limited to, paint overspray (intentional or not), fire-stopping material, drywall compound, or any other chemical, liquid, or compound that could come in contact with cables, cable jackets, cable termination points, or other equipment.

1. Cleaning of cables or equipment with harsh chemicals from a failure to comply with Protection of Cable and Equipment clause is unacceptable. Contractor shall replace any affected cable, cable components, or equipment in their entirety at Contractor’s sole cost.

F. Waste Materials: Contractor shall keep work area neat, orderly, and free from accumulation of waste materials. Remove trash and debris from the building and job site as required to maintain a clean work environment at all times. Rubbish shall be moved to a common trash point or receptacle on the job site as determined and directed by General Contractor or Owner.

G. Dumpsters: No construction debris shall be placed in building’s dumpsters. Contractor shall provide a dumpster for construction waste and debris at own expense. Said dumpster shall be emptied on a regular schedule. Location of dumpster shall be arranged through Building Management. Appropriate measures shall be taken to protect asphalt or other ground surfaces.

H. Ceiling Grid: Contractor shall not hang cable supports from ceiling grid wire.

I. Roof Deck: Contractor shall not shoot into the roof deck for mounting cable hangers.

J. Mounting: Equipment and enclosures shall be mounted plumb and square in relation to the structure.

K. Raised Floor: All cabling installed below the raised floor shall be placed in the provided cable trays with appropriate means to hold cable in place. If no cable tray exists, Contractor shall provide J-hooks to hold cables in place. Sleeves shall be utilized for cable egress.

L. Motorized Furniture: Care shall be taken to properly dress all cables placed within motorized furniture and provide sufficient cable length and strain relief to allow motorized elements to operate within their full range of travel.

M. Flexible Furniture: Care shall be taken to properly dress all cables placed within flexible or re-configurable furniture to provide sufficient cable length and strain relief to allow full range of travel for flexible furniture configurations.
3.04 Preparation

A. Existing Equipment: Prior to any installation, the Contractor shall prepare the site by removing any remaining debris, leveling equipment racks (where appropriate), and verifying information and systems stated to be in-place are ready for use.

B. Equipment for Installation: Prior to installation, Contractor shall ensure that required major equipment has been secured and is ready for installation.

3.05 Cleaning

A. Tool Clean-up: Contractor is not permitted to use restrooms for tool clean-up. A slop-sink may be provided in janitorial closet on each floor for cleaning of tools and equipment and as a source of water. Janitorial closet or maintenance area or shop shall be kept clean at all times. Contractor or Contractor’s Personnel found using restrooms for clean-up or other similar purposes shall be subject to removal from building.

B. Daily: At the end of each work period or day, Contractor shall remove excess packing, drilling remnants, and other non-equipment related parts, materials, or debris to ensure a clean, safe, and professional working environment.

C. Carpet: Contractor shall ensure that no damage to carpeting occurs as a result of their work. Contractor shall cover carpets in areas of work to prevent wire and other debris from entering the carpet.

3.06 Demolition

A. General: The Contractor shall be responsible for removal, collection, transportation, and recycling of all cabling and components that become abandoned as a result of this project. This shall include the delivery of cable and components to the proper recycling centers. If material is to remain on site for more than seven days after removal, Contractor shall coordinate with Owner for an acceptable storage location.

B. Verification: Contractor shall field-verify existing conditions prior to beginning demolition work. Any discrepancies shall be reported to the Consultant prior to the start of work in order to prevent disturbance of existing installation(s). Beginning work shall indicate acceptance of existing conditions. Contractor is responsible for immediately restoring any outages caused as a result of removing or damaging adjacent cabling, systems, or services.

C. Abandoned Cable: The Contractor shall remove all abandoned cable back to the headend. Where it is not possible to remove cables without damaging other cables that are to remain, such as in a shared conduit, the Contractor shall report these conditions to the Consultant for approval. These cables shall be cut at entry and exit points, leaving a minimum of 24” of cable at each end.

D. Cover Plates: The Contractor shall provide and install blank cover plates for any outlets or junction boxes that are to be left in place and from which all cables have been removed. Cover plates shall match the Project standard color and finish.

E. Equipment: The Contractor shall remove all equipment abandoned as part of this project. The Contractor shall be responsible for the delivery of this equipment to a proper recycling facility. Any electrical service connected to the equipment shall be properly decommissioned and labeled to prevent any safety issues.
F. Right of Refusal: The Owner shall have first right of refusal to any abandoned cable or equipment. The Owner has the right to remove any components from the equipment before it is recycled.

3.07 Fire Stopping

A. Contractor is responsible for applying fire-stopping material in and around all openings that it creates or are created for it, whether or not specifically indicated in specifications or project drawings, where code requires the use of fire stopping material.

B. Contractor shall ensure that all fire-stopping materials meet appropriate codes and are installed in a neat and workmanlike manner.

3.08 Waterproofing

A. Contractor is responsible for creating a waterproof seal in and around any openings to the outside environment that are created by Contractor or for systems being installed.

B. Contractor shall ensure that all waterproof materials meet appropriate codes and are applied according to good engineering practice.

3.09 Racks, Cabinets, and Hardware

A. Racks and Cabinets: Contractor shall assemble and install racks and cabinets.

B. Installation Hardware: Install hardware in a secure manner. Screws shall be tightened to a torque just sufficient to secure equipment without deforming washers beyond their original diameter.

C. Considerations: Rack mount equipment shall be secured as recommended by the manufacturer with consideration to airflow, power, and in/out connections.

D. Cross Connections: Where cross connections are required between equipment, interconnections shall be installed using cable management devices to secure cables in a neat and workmanlike manner, applying best industry practices.

3.10 Installation Requirements

A. Cable pulling shall be done in accordance with cable manufacturer’s recommendations and ANSI/IEEE C2 standards. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed.

B. All cable shall be pulled by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to ensure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a “break-away”, or other approved method.

C. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all installation work. During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of pathway entry and exit.

D. All cable shall be free of tension at both ends.

E. PLENUM rated cable shall be used in areas used for air handling or where required by code.
F. Contractor shall replace any cables that have been damaged or abraded during installation.

G. Pulling lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used and will not harden or become adhesive with age.

H. A pull cord (nylon; 1/8” minimum) shall be co-installed with all cable installed in any conduit or surface mount raceway.

3.11 Cable

A. Cable treatment: Cable shall be stored and handled to assure that it is not stretched, kinked, crushed, or abraded in any way. Bend radii shall meet manufacturer specifications and/or recommendations. Cable shall not be installed in ambient temperatures or moisture conditions above or below the rating of the manufacturer.

B. Splicing

1. Voice, data, and other twisted pair cables: No splices shall be installed in any voice, data or twisted pair cables.

2. Technology systems: No splices shall be installed in any cable less than five hundred (500) feet in length.

3. Digital multimedia/video cables: No splices are allowed in any digital multimedia/video cable.

4. Overhead paging systems: Cable splices for constant voltage overhead paging system shall occur only at speaker, amplifier or volume control knob locations.

C. Lengths

1. Variations: Where cables are to be of the same length, variations in the length shall be less than plus or minus ½ inch. Lengths of cables are based on the length of the unterminated signal conductors.

2. Labeling: Cables, regardless of length, shall be marked with a labeling scheme approved by Consultant.

3. Service Loops: A surplus of cable, located at or near the point of termination to facilitate potential future changes, shall be provided where appropriate. Cables shall have a minimum cable slack of 10ft (3m) at the telecommunication room(s) and 3.28ft (1m) at each telecommunications outlet in the suspended ceiling unless noted otherwise. Service loops shall be stored in an extended loop or in a figure-eight configuration, not in bundled loops.

D. Grouping

1. Cables shall be separated into like groups according to signal or power levels.

2. Power Cable Group: Power cables shall be secured to one side of the rack separate from any low-energy signal cable groups. Separation shall be a minimum of 4” in all directions.

3. Signal Cable Group: Signal cables shall be grouped according to signal type and secured to one side of the rack separate from any power cable groups. Separation shall be a minimum of 4” in all directions.

E. In Equipment Racks
1. Equipment rack wiring and cabling shall be neatly dressed.

2. Fastening: Rack cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame.

F. Support for Cables Outside of Equipment Racks

1. External wire and cables shall be supported at least every 5 feet (1.5m) from the structure and as required to maintain less than 12 inches of cable sag between supports without over-tensioning the cables. Contractor shall vary the precise distance between cable supports on long runs to avoid harmonics issues.

2. Hardware: Cables shall be supported by J-hooks, cable tray, or ladder rack. Hardware shall be secured to building structure using 3/8" threaded rod supports.
   a. Right Angles: Cables are to run at right angles to the structure, placed above ceiling in halls or corridors.
   b. Height: Cables shall not run above red iron joist.

G. Concealment: Contractor shall make every effort to conceal wiring and other apparatus into walls, floors, and ceilings, assuming code and good engineering practice allows and suggests. Cabling systems installed in public areas shall be installed within walls, ceiling, or floors or within surface wiring pathways, as dictated by codes and good engineering practice.

H. Velcro Straps for Horizontal Cabling: Straps shall be installed snugly without deforming cable insulation. Straps shall be spaced at uneven intervals not to exceed 4 feet.

I. Cable Ties and Velcro Straps within Equipment Racks and Cabinets: Ties and straps shall be installed snugly, without deforming cable insulation, at uneven intervals not to exceed 8 inches. Cable ties shall only be used for non-signal carrying cables. No sharp burrs shall remain where excess length of the cable tie has been cut.

J. Obstruction: Contractor shall notify Owner immediately if any obstruction or hazard is discovered in a pathway provided by others.

3.12 Connectors

A. Preparation: Cables shall be carefully prepared and connectors installed as directed by the manufacturer. Proper stripping devices and crimping tools shall be used.

B. Terminations: Connectors shall be carefully fitted to mating devices on equipment to avoid damage to mating contacts, inserts, or bodies. Specialized terminations shall be made in a neat and secure manner suited to the service of the wire and as directed by the manufacturer. Contractor shall use manufacturer specified terminations when those specifications exist.

C. Soldering: A person skilled in that practice shall execute soldered terminations. Any excessive insulation displacement resulting from soldering shall be grounds to require the Contractor to re-terminate the connector.

D. Adapters: Adapters shall be used only where the identity of the necessary type of connector is unknown at the time of installation, such as for Owner-provided equipment or in anticipation of future equipment upgrades, with Consultant’s approval.
3.13  Spare Parts and Remote Controls

A. Keys: Contractor shall turnover all keys, tagged and organized by type on individual key rings, to Owner upon project completion.

B. Refer to individual sections for spare parts and remote control requirements.

3.14  Equipment Installation

A. General: Contractor shall make system properly operational and physically secure by mounting equipment and related accessories into furniture, consoles, and racks as required. Manufacturer’s guidelines for installation shall be followed. Discrepancies in installation procedure or inability to complete a given task due to a shortage of materials or malfunctioning equipment shall be reported to Consultant immediately upon discovery.

B. Equipment Placement: Contractor shall locate equipment as indicated on drawings and as specified herein. Where such information is not provided, Contractor shall follow industry best practices and locate operable devices at convenient positions; heat generating devices at the top and seldom-accessed equipment below.

1. Unless otherwise specified, end user-operable devices shall be positioned within the range of front wheelchair access per ADA standards.

C. Equipment Installation: Equipment shall be installed as directed by the manufacturer using equipment manufacturer’s desktop mounting frames, equipment tubs, installation hardware, and techniques. Contractor shall be responsible for moving equipment from storage and for providing necessary personnel or devices to carry and lift equipment around obstacles and into operating position.

3.15  Firmware

A. Firmware shall be latest version supported by software and/or equipment as of Date of Acceptance.

3.16  Rough-In

A. Scheduling: Contractor shall make every effort to install systems per this specification in a timely manner including rough-in of cabling and other apparatus where appropriate to stay on schedule.

B. Protection of Environment: Where cabling and/or equipment is installed prior to other trades completing their work in an area, Contractor shall take necessary precautions to cover, wrap, or otherwise protect to reduce possible damage which may result from plastering, painting, cleaning, or other such work completed after installation and before substantial completion of the project.

3.17  Cutting, Drilling, Patching, and Painting

A. Coordination: Contractor is responsible for coordinating with the General Contractor and other trades when any cutting or drilling is required for the installation or proper performance of the specified systems.

B. Restoration: Contractor is responsible for returning all surfaces (including walls, floors, and ceilings) to their previous condition after any cutting.
3.18 Labeling

A. General: Rack-mounted equipment and hardware shall be labeled as required herein. Connectors, jacks, receptacles, outlets, cables, cable terminations, terminal blocks, rack mounted equipment, active slots of card frame systems, etc. shall be clearly, logically, and permanently labeled in a manner acceptable to Consultant.

B. Approval: Proposed wording and/or numbering schemes for labeling shall be provided to Consultant for review and written approval prior to procurement or installation.

C. Labels used shall be permanent and secure. Provide labeling as follows unless otherwise noted in a specific section:

1. Like Size: All labels, including engraved labels, shall be sized to match other labels used for same purpose.

2. Equipment Racks: For enclosed racks containing equipment, provide labels on each equipment rack rear door or console rear panel reading “No user serviceable parts. Refer service to qualified technician.”

3. Installer and Consultant Identification: Position at the front top center section of each equipment rack a label that states the names of system Installer and Consultant.

4. Custom Panels: Custom panel nomenclature shall be engraved, etched, or screened. Markings are to be designed to ensure consistency and clarity within and without of system. Verify markings and placements by submitting label sample layouts to Consultant for approval prior to procurement.


3.19 Fire-Stopping

A. If Contractor removes anything from an opening in a fire-rated wall, Contractor shall restore the fire-rating condition of the wall to the same condition as before Contractor started its work. Depending on the size of the opening, this may involve sheetrock patching, in addition to use of other appropriate fire-stopping materials.

3.20 Additional Engineering Services

A. General: Contractor is responsible for securing necessary engineering services where needed to meet the needs of the installation.

B. Change Orders: Only when Contractor can show that additional engineering services are needed as a result of changes to the scope of the services being requested in the contract documents will Owner entertain a Change Order Request for these services.

3.21 Testing

A. Procedure: Contractor shall develop a rigorous testing procedure to ensure full functionality and durability of installed systems under heavy-use conditions.

B. Supplies: Contractor shall supply testing equipment needed to verify compliance with specifications found in these documents.

C. Schedule: Contractor shall complete required testing prior to the substantial completion inspection by Owner and Consultant.
D. Data: Test data shall be properly documented and recorded so that it is available for final inspection.

E. Quality Control: Testing may be repeated during the inspection process at the request of Owner or Consultant.

F. Prior to energizing or testing the system, Contractor shall ensure the following:
   1. Installation: Products are installed in a proper and safe manner per the manufacturer’s instructions.
   2. Cleanliness: Products are neat, clean, and unmarred and parts securely attached. Dust, debris, solder, splatter, etc. is removed.
   3. Cables and Connections: Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
   4. Grounding: Electronic devices are properly grounded.
   5. AC Power: Each AC power receptacle is tested with a circuit checker for proper hot, neutral, and ground connections prior to connecting equipment.

3.22 Grounding
   A. Refer to Section 27 05 26 for specific Grounding and Bonding installation requirements.

3.23 Training Program
   A. Contractor shall provide training in the manner delineated below in addition to specific requirements identified in subsequent sections.
   B. Contractor shall provide audio-video recording of each training session to Owner.
   C. Prior to scheduling or delivering End User training, Contractor shall confirm that:
      1. Closeout submittals have been accepted by Owner and Consultant.
      2. Final closeout inspection has been completed and punch list items rectified.
      3. Training schedule dates have been coordinated with and approved by Owner and Consultant.
   D. Training shall include:
      1. Approved handouts.
      2. Practical and comprehensive operation of systems.
      3. Basic system troubleshooting techniques.
      4. Basic system maintenance.
   E. Training Blocks
      1. Training time is defined as those hours specifically set aside for the sole purpose of training end users. Credited time will not be given for any time spent providing instructions to the Owner’s staff for a system not completed or that has not passed final acceptance by the Owner and Consultant, or training performed outside of the approved training program.
2. This training will be divided into training session "Blocks" as coordinated with the Owner.
   a. The first training session block shall consist of training intended for the common system operators. Such training, at a minimum, shall include the day to day use of the system.
   b. The second training session block shall consist of training administrators of the day to day administration of the system. Such training, at a minimum, shall include use of the administration control functions of the systems, user setup, and filtering and pulling reports.
   c. The third training session block shall consist of training administrators on system troubleshooting, maintenance, and updates. Such training, at a minimum, shall include using the system tools to diagnose issues, diagnosing common physical equipment issues, performing simple maintenance, and performing system updates.
   d. The forth training session block shall consist of a training session structured for high-level users, for example staff trainers who will provide instruction to other users and will include advance system configuration and operational knowledge needed to maintain and manage all specified technology systems. The Contractor may elect to engage the Manufacturer(s) in certifying the high-level end users in the systems at no cost to the Owner.

F. The Contractor shall issue a certificate of training completion to the trainees upon completion of their training. Such certificates must be signed by both the trainer and trainee(s) for the Contractor to receive training credit.

3.24 Warranty and Maintenance Program

A. Contractor shall provide a warranty conforming to the stipulations below in addition to specific requirements identified in subsequent sections.

B. As part of the base proposal cost, the Contractor shall include a 1-year turnkey warranty period with full support costs.

   1. Pricing for warranty services to be provided in years two through five shall be itemized on the Contract’s Unit Pricing Form as part of a complete response. The Owner may fund the additional warranty services separately or not at all at the Owner’s discretion.

C. The Warranty period shall begin after all punch list items have been rectified. The Contractor shall receive a letter of completion from the Consultant and Owner indicating project completion and starting the warranty period.

D. The warranty and support work included in this contract shall cover the following materials, software, and services, without additional cost to the Owner:

   1. Inspections, preventative maintenance, and testing of equipment and components. The Contractor shall schedule a 10-month on-site preventative system review 10-months into each year of warranty and support including system inspections, preventive maintenance, software upgrades/patches, and testing of equipment and components.


   3. Labor, travel, equipment, materials, and transportation cost for all services covered by this warranty.

E. Response Time: Contractor shall respond to calls for warranty services in a timely manner as delineated below.
1. The Owner reserves the right to make the final determination of emergency or normal service calls and the right to coordinate the best times for service of any system failure.

2. Emergency service calls are defined as failures which prohibit the use of a typical system function(s) and pose a life safety concern, or such failures which cause a major impact to the Owner’s daily operations.
   a. The Contractor shall provide remote service diagnosing the impact within two (2) hours after notification by the Owner.
   b. If remote service does not correct the reported issue, the Contractor shall provide on-site service correcting the impact within four (4) hours after notification by the Owner.

3. Normal service calls are defined as failures which prohibit the use of typical system function(s) but which do not inhibit critical system usage, do not pose life safety concerns, and do not create a major impact to Owner’s daily operations.
   a. The Contractor shall provide remote service correcting the impact within twenty-four (24) hours after notification by the Owner.
   b. If remote service does not correct the reported issue, the Contractor shall provide on-site service correcting the impact within forty-eight (48) hours after notification by the Owner.

4. The Contractor shall supply Service Request forms and or proper contact procedure to the Owner with instructions for proper notification of the Contractor for warranty service. By following said instructions, the Owner shall constitute proper notification for any needed warranty service.

F. Repair Time: Contractor shall locally stock critical parts in sufficient quantities such that emergency repair or replacement shall be guaranteed within twelve (12) hours. Temporary replacements within this time period shall be acceptable, provided temporary replacements do not compromise system functionality and provided permanent replacement is achieved within ninety-six (96) hours. Contractor may contact the Owner for use of Owner supplied spare parts where delay of system repair will have negative impact on system performance.

G. Transmittal: A copy of this Warranty shall be delivered to and signed for by the Owner’s representative whose primary responsibility is the operation and care of these systems. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.

H. Registration: Contractor shall register Warranty papers for all equipment and software in the name of the Owner and furnish reproductions of all equipment Warranty papers to the Owner with the Final Submittals.

I. Subcontracting: Warranty service work may not be subcontracted except with specific permission and approval by the Owner.

   1. Service/Warranty Procedures: Contractor shall submit a warranty service plan containing all contact information and Owner service call directions for Owner review with project close-out submittals.

J. Resolution of Conflicts:

   1. The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory and stating specific areas of dissatisfaction in writing.
2. If the Contractor or his approved Subcontractor does not resolve such stated areas of dissatisfaction within ninety-six (96) hours, the Owner may appoint an alternative service agency or person to fulfill the terms of the Warranty at the expense of the Contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system or component which is chronically malfunctioning is brought into compliance with the standards of performance as contained herein and published by the manufacturers of the equipment installed.

End of Section
SECTION 27 05 00  COMMUNICATIONS GENERAL REQUIREMENTS

Part 1 - General

1.01  Scope

A. Refer to Section 27 00 00 for additional project scope information.

B. This section describes the products and execution requirements related to furnishing and installing Category 5e/6/6a Cabling and Termination Components and related subsystems as part of a Structured Cabling System.

C. Backbone system comprising copper and fiber optic cabling and horizontal (station) cabling is covered under this document.

D. Others will provide the network electronics for the LAN within the Telecom Rooms (TRs) and will be responsible for connecting the new cabling infrastructure to the LAN. The Contractor, however, shall supply the patch cords. The Contractor shall be available on site during the crossover to assist with any cabling issues that may occur during the connection.

E. The Electrical Contractor shall install conduits and surface raceway for new technology outlet locations unless otherwise noted.

F. The Telecommunication Contractor shall provide and install all sleeves through the wall penetrations as required whether or not specifically marked on Project Drawings, unless otherwise noted.

G. All cables and related terminations support, and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following section(s).

H. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the Electrical Code in the state where the work is to be performed, and present manufacturing standards.

I. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

1.02  Related Work

A. Section 27 00 00 – General Technology Requirements

B. Section 27 05 23 – Pathways for Technology Systems

C. Section 27 05 26 – Grounding and Bonding for Technology Systems

D. Section 27 11 00 – Communications Equipment Rooms

E. Section 27 13 00 – Communications Backbone Cabling

F. Section 27 15 00 – Communications Horizontal Cabling

G. Section 27 16 00 – Communications Connecting Cords
H. Section 27 18 00 – Communications Labeling and Identification
I. Section 27 40 00 – AV/Multimedia General Requirements
J. Section 27 60 00 – Physical Security General Requirements
K. Section 27 62 00 – Electronic Access Control System
L. Section 27 64 00 – Video Surveillance System
M. Section 27 66 00 – Intrusion Detection System

1.03 Definitions
A. Refer to Section 27 00 00 for additional definitions.

1.04 Reference Standards and Codes
A. Refer to Section 27 00 00 for additional requirements.
B. All references relate to the current version adopted by the city/county according to the authority having jurisdiction (AHJ). If the city/county has not adopted a version the latest version shall be utilized.
C. ASTM B633: Specification for Electrodeposited Coatings of Zinc on Iron and Steel
D. ASTM A653: Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process
E. ASTM A123: Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel
F. ASTM A510: Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
G. ANSI/TIA 569-C: Telecommunications Pathways and Spaces
H. ANSI/TIA 568-C.0, 1, 2, 3, 4: Commercial Building Telecommunications Standard
I. ANSI/TIA-598-C-2005 – Optical Fiber Cable Color Coding
J. ANSI/TIA 606-B: Administration Standard for Telecommunications Infrastructure
K. ANSI/TIA 942-A: Telecommunications Infrastructure Standard for Data Centers
L. ANSI/TIA 607-B: Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
M. IEEE: National Electrical Safety Code® (NESC®)
   standards.ieee.org/about/nesc

1.05 Qualifications
A. Refer to Section 27 00 00 for additional requirements.
B. Premises Distribution System: Written certification that the premises distribution system complies with the EIA ANSI/TIA/EIA-568-C.0,1, 2, 3, EIA ANSI/TIA/EIA-569-B, and ANSI/TIA/EIA-606-A.
C. Materials and Equipment: Where materials or equipment are specified to conform, be constructed, or be tested to meet specific requirements, Contractor shall supply, upon request by Consultant or Owner, certification that the items provided conforms to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, will be acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications.

D. Certifications

1. The Contractor shall have an RCDD (Registered Communication Distribution Designer) on staff assigned to manage this Project; documented proof shall accompany the proposal response.

2. All installing personnel shall have completed and be certified in manufacturer training or BICSI (Building Industry Consulting Service International) installation training for UTP infrastructure systems, or the Contractor shall contract with manufacturer for installation of all proposed components. Company Certifications shall accompany the proposal response.

3. The Contractor’s technicians shall be certified and trained in the connectivity hardware which is being installed.

4. The Contractor shall submit certification that installers are factory certified to install and test the provided products. No less than half of the crew to be used for the telecommunications installation shall be trained by that manufacturer for the work.

1.06 Pre-Construction Submittals

A. Shop Drawings in addition to requirements in Section 27 00 00:

1. Equipment rack elevation details

2. Elevations of telecommunication room walls with planned mounted equipment

3. Outlet faceplate details for all outlet configurations, sizes, and cable types

4. Overhead telecommunication room enlargements, providing dimensions of room and clearance for maintenance and operation

1.07 Construction Progress Submittals

A. Refer to Section 27 00 00 for requirements.

1.08 Closeout Submittals

A. Refer to Section 27 00 00 for requirements.

1. Data cable test results

2. CD containing:

   a. As-built drawings (CAD format)

   b. As-built drawings (PDF format)

   c. Detailed test results in original tester format (e.g. Fluke Linkware)
d. Detailed cable test results in PDF format

3. Warranty certification from connectivity manufacturer

1.09 Delivery, Storage, and Handling

A. Contractor shall be responsible for all materials until completion of Project.

B. Cable shall be stored according to manufacturer’s recommendations at minimum. In addition, cable shall be stored in a location protected from vandalism and weather.

C. If cable is stored outside, it shall be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees Fahrenheit, the cable shall be moved to a heated (minimum 50 degrees Fahrenheit) location. If necessary, cable shall be stored off site at the Contractor’s expense.

D. If the Contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner.

E. Commercial off-the-shelf manuals shall be furnished for operation, installation, configuration, and maintenance for all products provided as a part of the premises distribution system. Specification sheets for all cable, connectors, and other equipment shall be provided.

Part 2 - Products

2.01 Substitutions

A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Fire Stopping Materials

A. Refer to Section 27 00 00 for additional requirements.

Part 3 - Execution

3.01 Testing

A. Refer to Section 27 00 00 for additional requirements.

3.02 Training

A. Refer to Section 27 00 00 for additional requirements.

3.03 Warranty

A. Refer to Section 27 00 00 for additional requirements.

B. The Contractor shall provide to the Owner a manufacturer’s 15-year minimum warranty certificate for all materials, equipment, etc. Upon successful completion of the installation and subsequent inspection, the Owner shall receive the numbered certificate from the manufacturing connectivity hardware (patch panels, jacks, parch cords 110 blocks, etc.) company registering the installation. This warranty shall include all labor, materials, and travel time.
C. The warranty shall ensure against product defects and guarantee that all approved cabling components exceed the specifications of TIA/EIA-568-C and ISO/IEC IS 11801 for cabling links/channels, and that the installation will exceed the loss and bandwidth requirements of TIA/EIA 568-C ISO/IEC IS 11801 for fiber links/channels for a fifteen (15) year period. The warranty shall apply to all passive structured cabling system components.

D. The warranty shall cover the failure of the wiring system to support the application that it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the TIA/EIA 568-C or ISO/IEC IS 11801 component and link/channel specifications for cabling. Such warranty shall apply for a minimum of a fifteen (15) year period.

E. The warranty shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective products(s), labeling of the new components, and testing of the circuit(s) at no cost to the Owner.

3.04 Examination

A. Verification of Conditions: Contractor shall examine areas and conditions under which work is to be performed and identify conditions detrimental to proper and timely completion.

B. Contractor shall verify that cable lengths comply with published standards.

C. Contractor shall notify Owner of any proposed installation which is expected to exceed maximum lengths prior to installation of cable.

D. Contractor shall consult with Owner regarding alternative routing or location of cable.

E. Contractor shall not proceed until unsatisfactory conditions have been corrected.

3.05 Spare Parts

A. Suggested List: Contractor is requested to submit a list of suggested spare parts with an offered price, allowing Owner to select appropriate parts.

B. Means of Obtainment: Contractor shall state where spare parts can be obtained after the installation.

3.06 Installation Requirements

A. Refer to Section 27 00 00 for additional requirements.

3.07 Cooperation

A. The Contractor shall cooperate with other trades and General Contractor’s personnel in locating work in a proper manner.

B. Should it be necessary to raise, lower, or move longitudinally any part of the work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

3.08 Testing and Acceptance

A. The Contractor shall perform acceptance tests as indicated below for each subsystem (backbone, station, etc.) as it is completed.
B. The Contractor shall supply all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor shall provide a summary of the proposed test plan for each cable type, including equipment to use, setup, test frequencies or wavelengths, results format, etc. The Consultant will approve the method of testing.

C. The Contractor shall visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. The Contractor shall provide the Consultant with a written certification that this inspection has been made.

D. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Consultant. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week advance notice to the Consultant and Owner to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

E. Tests related to connected equipment of others shall be done only with the permission and presence of Contractor involved. The Contractor shall ascertain that testing only as required to prove the wiring connections are correct.

F. The Contractor shall provide Consultant with test results and descriptions of the testing methodology, including the date of the tests, the equipment used, and the procedures followed. At the request of the Consultant, the Contractor shall provide copies of the original test results.

G. All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the Contractor’s expense. The applicable tests shall then be repeated.

H. Backbone voice cables shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the termination blocks (e.g., 110). Any mispositioned pairs shall be identified and corrected. The percentage of “bad” pairs shall not exceed 1% in any backbone (riser or tie) cable based on total pair count. All bad pairs shall be identified and documented.

I. The Consultant or Owner may request that a 10% random field re-test be conducted on the cable system to verify documented findings.
   1. If requested, the Contractor shall test up to 10% of cable links at no cost to the Owner.
   2. Tests shall be a repeat of those defined above and under Testing and Acceptance. If findings contradict the documentation submitted by the Contractor, additional testing shall be performed to the extent determined necessary by the Consultant, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.09 Fire Stopping

A. Contractor shall seal any openings created for cable pass-through between floors or through fire rated walls. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work.

B. Creation of such openings as are necessary for cable passage between locations as shown on the Drawings shall be the responsibility of the Contractor. Any openings created by or for the Contractor and left unused shall also be sealed as part of this work.
SECTION 27 05 23 PATHWAYS FOR TECHNOLOGY SYSTEMS

Part 1 - General

1.01 Scope
   A. Refer to Section 27 00 00 for additional project scope information.

1.02 Related Work
   A. Section 27 00 00 – General Technology Requirements
   B. Section 27 05 00 – Communications General Requirements
   C. Section 27 05 26 – Grounding and Bonding for Technology Systems
   D. Section 27 11 00 – Communications Equipment Rooms
   E. Section 27 13 00 – Communications Backbone Cabling
   F. Section 27 15 00 – Communications Horizontal Cabling
   G. Section 27 16 00 – Communications Connecting Cords
   H. Section 27 18 00 – Communications Labeling and Identification
   I. Section 27 40 00 – AV/Multimedia General Requirements
   J. Section 27 41 00 – Audio Visual Systems
   K. Section 27 51 00 – Distributed Communications Systems
   L. Section 27 60 00 – Physical Security General Requirements
   M. Section 27 62 00 – Electronic Access Control System
   N. Section 27 64 00 – Video Surveillance System
   O. Section 27 66 00 – Intrusion Detection System

1.03 Definitions
   A. Refer to Section 27 00 00 for additional definitions.

1.04 Reference Standards and Codes
   A. Refer to Section 27 00 00 for additional requirements.

1.05 Qualifications
   A. Refer to Section 27 00 00 for additional requirements.

1.06 Pre-Construction Submittals
   A. Refer to Section 27 00 00 for additional requirements.
1.07 Construction Progress Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.08 Closeout Submittals
   A. Refer to Section 27 00 00 for additional requirements.

Part 2 - Products

2.01 Substitutions
   A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Wire Basket Tray Runway
   A. As shown on the Project Drawings, the Contractor shall provide and install sufficient wire basket tray runway systems to support horizontal cable bundles.
   B. The Contractor shall provide all necessary labor, supervision, materials, equipment, tests, and services to install complete wire basket tray runway systems.
   C. Wire basket runway systems shall include, but are not limited to, straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports, and accessories.
   D. Specifications and Drawings are for assistance and guidance, but exact routing, locations, distances, and levels will be governed by actual field conditions.
   E. Contractor shall ensure that all straight section longitudinal wires are installed with no bends, kinks, or twisting.
   F. Wire basket runway shall be made of high strength steel wires and formed into a standard 2-inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along runway sides (flanges) shall be rounded during manufacturing to prevent damage to cables and injury to installers.
   G. All fittings shall be field formed as needed.
   H. All splicing assemblies shall be the bolted type using serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 stainless steel. Splicing assemblies shall provide a continuous ground connection.
   I. Wire Basket Tray shall be grounded only at the Telecommunications Room ground bus bar.
   J. Cable Drop Out/Waterfall
      1. Where cables bundles transition from tray to tray or tray to conduit or sleeve of varying elevations the Contractor shall provide and install a radius control device. This device shall be a waterfall or drop out device and shall be properly sized to accommodate cable bundle plus 20% future growth.
   K. T-sections of tray shall be made using T-section fittings.
   L. Straight section splices shall be made using splice plates.
M. Wire basket runway supports shall be of the trapeze hanger type.

N. Trapeze hangers shall be supported by 3/8 inch diameter rods.

O. Tray shall have an electro zinc finish or a flat Black finish wherever finished installation will be visible to end users.

P. Accessories (connectors, splice plates…) shall be painted to match tray finish.

Q. Contractor shall refer to project drawings for cable tray sizing.

R. Manufacturer: Cable trays and accessories shall be of one of the following manufacturers
   1. Panduit

2.03 Cable Hook Systems

A. In the areas where the cables are required to be run in a “free-air” plenum, a cable hook system shall be used.

B. Cable hooks shall be capable of supporting a minimum of 30 lbs. with a safety factor of 3.

C. Spring steel cable hooks shall be capable of supporting a minimum of 100 lbs. with a safety factor of 3 where extra strength is required.

D. Cable hooks shall be Category 6a or better rated.

E. Follow manufacturer’s recommendations for allowable fill capacity for each size of cable hook.

F. Installation and configuration shall conform to the requirements of the ANSI/ EIA/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.

G. Cable hooks shall:
   1. Have a flat bottom and provide a minimum of 1 5/8” cable bearing surface.
   2. Have 90-degree radiused edges to prevent damage while installing cables.
   3. Be designed so the mounting hardware is recessed to prevent cable damage.
   4. Have a steel cable latch retainer to provide containment of cables within the hook.
   5. Have a retainer that shall be removable and reusable.
   6. Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, and floor posts, to meet job conditions.

H. Factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed.

I. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653 G90. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.

J. Cable hooks for corrosive areas shall be stainless steel, AISI type 304.
K. Cable hooks shall be B-Line series BCH21, BCH32 or other manufacturer that meets these specifications

2.04 Surface Raceway

A. In areas where surface raceway will be used as a cable path, no exposed cable shall be permitted.

B. With the agreement of the Consultant and Owner, where telecommunications outlets are to be located in areas where the walls cannot be fished, the station wire serving these outlets shall be covered with raceways. No exposed wire shall be permitted within offices, laboratories, conference rooms, or like facilities. Contractor shall attempt to fish hollow walls, use existing conduit, or exhaust all other options to conceal cabling prior to installing surface raceway.

C. The raceway shall originate from a surface mounted box located off the floor, be attached to the wall, and terminate above the ceiling. The outlet box height shall match existing electrical receptacle height. Raceway for wall-mounted phone locations shall originate from a surface mounted box with the top of the box located 48" off the floor.

D. Raceway finish shall match finish of project electrical raceway. All fittings including but not limited to extension boxes, elbows, tees, and fixture boxes shall match the color of the raceway.

E. Telecommunication outlet faceplates shall match electrical faceplate standards for finish.

F. The raceway and all system devices shall be UL listed, exhibit nonflammable self-extinguishing characteristics, tested to specifications of UL94V-0, and be Category Compliant as defined by TIA/EIA 568.

G. Raceway turns or bends shall conform to manufacturer specifications or recommendations and industry best-practices for UTP and fiber optic cable minimum bend radius.

H. Non-Metallic raceway systems:

1. Non-metallic surface raceway shall have an adhesive-applied base and have a hinged snap-on cover. The raceway shall be manufactured of natural PVC compounds.

2. The raceway system shall be made up of the following components:
   a. Raceway channel shall be Panduit LD5.
   b. Surface mount outlet boxes shall be Panduit JBX3510EI-A.
   c. Dropped ceiling connectors shall be Panduit DCF5EI-X or DCEFXEI-X.
   d. Right angle fittings shall be Panduit RAFC5EI-X.
   e. Coupler fittings shall be Panduit CFX5EI-X.

I. All raceway systems shall be installed complete as specified herein and in manufacturer recommendations.

2.05 Cable Pathway Sleeves

A. The Contractor shall only provide when re-enterable sleeves are not possible.
B. The Contractor shall provide all necessary wall penetration for cable pathways whether or not specifically shown on Project Drawings.

C. All wall penetrations shall have a metallic sleeve(s) as required to maintain a maximum 40% fill ration.

D. All sleeves shall be properly firestopped by this Contractor.

E. Contractor shall provide all core holes, pathways and sleeves (minimum 1.25" c).

F. Contractor shall install non-metallic threadless insulating bushings on end of all conduits.

G. Conduit Core Holes and Sleeves thru Floor: For all floor penetrations, Contractor shall provide IMC conduits with threaded steel couplings set flush with finish floor. Extend 6" above finish floor with IMC before any termination.

2.06 Re-Enterable Firestop Sleeves

A. Manufacturer:
   1. STI EZ Path
   2. Hilti Speedsleeve
   3. Or approved equal

2.07 Metal Conduits and Fittings

A. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with TIA-569-B.
   3. GRC: Comply with ANSI C80.1 and UL 6.
   4. EMT: Comply with ANSI C80.3 and UL 797.
   5. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
      a. Fittings for EMT:
         i. Material: Steel
         ii. Type: Setscrew
   6. Expansion Fittings: Steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

2.08 Outlet Boxes

A. General Requirements for Outlet Boxes
   1. Comply with TIA-569-B.

B. Metallic outlet boxes and device covers shall be galvanized steel not less than 1/16" thick.
C. The dimensions of the metallic outlet box shall be 2"x4", 4"x4" and 6"x4" with a minimum depth of 2.5". See drawings for details.

D. Metallic outlet boxes shall be equipped with single device cover (or two-device cover where needed).

E. Where installed in plaster, gypsum board, etc., covers shall be raised to compensate the thickness of the wall.

F. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

G. Where metallic outlet boxes are to be empty for future use, blank covers shall be used.

H. Gangable boxes are not allowed.

Part 3 - Execution

3.01 Testing

A. Refer to Section 27 00 00 for additional requirements.

3.02 Training

A. Refer to Section 27 00 00 for additional requirements.

3.03 Warranty

A. Refer to Section 27 00 00 for additional requirements.

3.04 Wire Basket Tray Runway

A. Basket tray shall be installed in accordance with recognized industry practices, to ensure that the cable tray equipment complies with requirements of NEC, applicable portions of NFPA 70B and NECA’s “Standards of Installation” pertaining to general electrical installation practices.

B. Coordinate installation of wire basket runway with other electrical work as necessary to properly interface installation of wire basket runway with other work.

C. Provide sufficient space encompassing wire basket runways to permit access for installing and maintaining cables.

D. Test wire basket runways to ensure electrical continuity of bonding and grounding connections and to demonstrate compliance with specified maximum grounding resistance.

3.05 Cable Hook System

A. J-hooks fabricated to contain data/voice and video cables may be used to support 25 or fewer cables in each hook. J-hooks are to be fastened to building steel with beam clamps, suspended from ceiling slab with threaded rod, or anchored to the wall. All J-hooks shall be hung straight and level. No other installation technique will be authorized unless pre-approved.
B. Three tiered double-sided J-hook configurations shall contain a maximum of 25 cables per hook or 150 cables. Smaller configurations may be used as bundles decrease in size, maintaining no more than 25 cables per hook.

C. Bundles surpassing 150 cables shall be supported by hangers, fabricated of 3/8” threaded rod and 24” Unistrut. Hangers shall also be installed where the installation of a three-tiered J-hook system is not appropriate for the ceiling space, or where blocked by other trades' work.

D. Cable bundles consisting of fewer than 10 cables may be supported by single J hooks.

E. All cable support in the main cable path shall be installed every four feet. Small cable bundles (under 25) not in the main path may be supported every five feet.

F. A sag shall be maintained between supports of 6”, to reduce cable strain. Velcro is an appropriate method of securing cables, when properly used and not over tightened.

G. Proper cable support is extremely important to the Owner, and care shall be taken by the Contractor to provide and install the appropriate supports. Supports found to be inadequate will be replaced.

H. Cable bundles including voice/data cabling shall not have plastic cable ties.

I. All cable trunks shall have radius controlled cable waterfalls where trunk drops from conduit, sleeve or tray from horizontal path to vertical path.

3.06 Surface Raceway System

A. In areas where surface raceway will be used as a cable path, no exposed cable shall be permitted.

B. With the agreement of the Consultant and Owner, if a telecommunications outlet is required in an area where the walls cannot be fished, the station cable serving these outlets shall be covered with raceway. No exposed cable shall be permitted within offices, laboratories, and conference rooms, or like facilities. Contractor shall attempt to fish hollow walls, use existing conduit, or exhaust all other options to conceal cabling prior to installing surface raceway.

C. The raceway shall originate from a surface mounted box located off the floor and be attached to the wall and terminate above the ceiling. The outlet box height shall match existing electrical receptacle height. Raceway for a wall-mounted location shall originate from a surface mounted box with the top of the box located 48” off the floor.

D. Minimum bend radius shall be adhered to for UTP and fiber optic cable.

E. Where raceway is to be installed on painted, smooth, finished surfaces, the Contractor shall clean surface prior to installing raceway.

F. Where non-metallic raceway is to be installed on non-smooth surfaces such as wallpaper, unpainted brick, concrete, etc., the Contractor shall use flat-head screws in addition to the adhesive backing to fasten channel to surfaces.

G. Where Contractor is required to install metallic raceway, the raceway base shall be installed using flat-head screws and following all manufacturer’s recommendations.

H. Where new outlet locations are indicated on Project Drawings as having existing Wiremold™ type raceway, the Contractor shall remove existing raceway from wall and install new
specified raceway to cover any damage or markings caused from removing existing raceway product.

I. All surface raceway shall be mounted level and plumb. Where the Owner considers raceway channels to be installed unsatisfactorily, the Contractor shall remove and replace necessary channels at no additional cost to the Owner.

J. Suitable insulating bushings and inserts shall be used at connections to outlets and corner fittings. Dropped ceiling end fittings shall be utilized where raceway channel connects to dropped accessible ceiling tile. In rooms with drywall ceilings, open ceilings, or non-accessible ceilings, the Contractor shall extend raceway to the nearest location, hallway, or corridor that has accessible ceiling cavity. All cables shall be concealed.

3.07 Pathway Applications

A. Indoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT
   2. Concealed in Ceilings and Interior Walls and Partitions: EMT

B. Minimum Pathway Size for Data: 1-inch trade size. Cable fill shall not exceed a 40% fill ratio.

C. Pathway Fittings: Compatible with pathways and suitable for use and location.
   1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.

3.08 Installation

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Support conduit within 12 inches of enclosures to which attached.

H. All conduit penetrations shall comply with all applicable fire codes. All conduit penetrations in fire-rated walls or floors shall be sealed and fire proofed to at least the rating of the penetration area.

I. Conduits shall be routed in the most direct route, with the fewest number of bends.
J. There shall be no continuous conduit sections longer than 100 feet. For runs that total more than 100 feet, insert junction or pull boxes (or gutters if appropriate) so that no continuous run between pull boxes is greater than 100 feet.

K. There shall be no more than two 90-degree bends (180 degrees total) between conduit pull boxes.

L. Changes in direction shall be accomplished with sweeping bends observing minimum bend radius requirements above. Do not use pull boxes for direction changes unless specifically designated otherwise in the Drawings.

M. Stub-ups to Above Recessed Ceilings:
   1. Use EMT for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb. tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

3.09 Outlet Boxes

A. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

B. Exact locations of the outlet boxes shall be coordinated with the electrical contractor and other trades.

C. The approximate locations of the outlets are indicated on the drawings. The exact locations shall be determined at the building. The right is reserved to change without additional cost, the exact location of any outlet, a maximum of 10' before it is permanently installed.

D. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a rain tight connection between box and cover plate or supported equipment and box.

E. Horizontally separate boxes by a minimum of 12" mounted on opposite sides of walls so they are not in the same vertical channel.
F. Outlet boxes installed back to back in fire-rated walls shall be separated horizontally by a minimum of 24".

G. Install all outlet boxes in finished areas flush with the wall. Maintain ¼" or less space between outlet box front and finished wall surface.

H. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

I. Outlet boxes shall be firmly anchored in place and shall not depend on the cover plate to hold it secure to the wall.

J. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

K. Any surface boxes shall have rounded corners and edges. Surface boxes must be approved by Owner prior to installation.

3.10 Riser Conduits

A. Conduits entering equipment rooms shall be reamed or bushed and terminated not more than 4" from a wall and within 12" of room corners.

B. Conduits entering equipment rooms from below floor shall be terminated not more than 4" above finished floor.

C. Conduits shall not be less than 4" trade size and be equipped with a measured pull line at 12" increments rated at a minimum 1200 pound test.

D. Provide restorable fire stops inside and around conduits as recommended by UL1479 or ASTM E814 for all conduits penetrating fire-rated construction.

E. Provide an insulating press fit bushing on all telecommunications riser conduits. Bushings must be rated to be used in an environmental air handling space (Plenum).

3.11 Sleeve-Seal Installation for Communications Penetrations

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.12 Firestopping

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

End of Section
SECTION 27 05 26  GROUNDING AND BONDING FOR TECHNOLOGY SYSTEMS

Part 1 - General

1.01  Scope

A. Refer to Section 27 00 00 for additional project scope information.

1.02  Related Work

A. Section 27 00 00 – General Technology Requirements

B. Section 27 05 00 – Communications General Requirements

C. Section 27 05 23 – Pathways for Technology Systems

D. Section 27 11 00 – Communications Equipment Rooms

E. Section 27 13 00 – Communications Backbone Cabling

F. Section 27 15 00 – Communications Horizontal Cabling

G. Section 27 16 00 – Communications Connecting Cords

H. Section 27 18 00 – Communications Labeling and Identification

I. Section 27 40 00 – AV/Multimedia General Requirements

J. Section 27 41 00 – Audio Visual Systems

K. Section 27 51 00 – Distributed Communications Systems

L. Section 27 60 00 – Physical Security General Requirements

M. Section 27 62 00 – Electronic Access Control System

N. Section 27 64 00 – Video Surveillance System

O. Section 27 66 00 – Intrusion Detection System

1.03  Definitions

A. Refer to Section 27 00 00 for additional definitions.

1.04  Reference Standards and Codes

A. IEEE C2 - National Electrical Safely Code

B. IEEE Std. 837-2002, or latest version – Standard for Qualifying Permanent Connections Used in Substation Grounding

C. ANSI/TIA-607 - Commercial Building Grounding and Bonding Requirements for Telecommunications

D. NFPA 70E - Standard for Electrical Safely in the Workplace
E. ANSI/NECA/BICSI-607 - Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings

F. UL 467 - Standard for Grounding and Bonding Equipment

G. Refer to Section 27 00 00 for additional requirements.

1.05 Qualifications

A. Refer to Section 27 00 00 for additional requirements.

1.06 Pre-Construction Submittals

A. Refer to Section 27 00 00 for additional requirements.

1.07 Construction Progress Submittals

A. Refer to Section 27 00 00 for additional requirements.

1.08 Closeout Submittals

A. Refer to Section 27 00 00 for additional requirements.

Part 2 - Products

2.01 Substitutions

A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Grounding and Bonding Cable

A. The grounding and bonding cable shall be stranded copper conductors.

B. The grounding and bonding cables shall have a green jacket color and riser or plenum rated as required.

C. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications, or as required by NFPA 70, whichever is larger. Differentiate between normal ground and isolated ground when both are used within the same facility.

2.03 Grounding and Bonding Busbars

A. Telecommunications Grounding Busbar (TGB)

   1. Factory-drilled solid copper with holes to accommodate lugs. Field manufactured busbars are not acceptable.

   2. 0.25” thick x 4” wide

   3. Sized for current applications and future growth, no less than 12”

   4. Insulated from its support

   5. Shall be an electro-tin plated busbar

   6. Maintain a minimum of 2” of clearance from wall
7. UL listed and BICSI certified

B. Horizontal Equipment Rack or Cabinet Busbar
   1. Mounts to standard 19” Rack or Frame
   2. Capacity: 6 Double hole lugs
   3. Shall be an electro-tin plated busbar
   4. UL listed and BICSI certified

C. Vertical Equipment Rack or Cabinet Busbar
   1. Mounts to vertical rail or inside of cabinet in 19” or 23” equipment rack or frame.
   2. Capacity: 9 Double hole lugs
   3. Shall be an electro-tin plated busbar
   4. UL listed and BICSI certified

2.04 Mechanical Connectors

A. Mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers, and lock washers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.

B. Split bolt connector types are not allowed.

C. Connectors shall meet or exceed UL 467.

2.05 Compression Lugs

A. Shall be UL & CSA listed

B. Shall meet or exceed the performance requirements of IEEE 837, latest revision

C. Compression type

D. Shall be manufactured from pure wrought copper. Conductivity of this material shall be no less than 99% by IACS standards.

E. Shall be electro-tin plated

F. Lugs shall be 2-hole. Single hole lugs are not allowed

G. Long barrel that will allow a minimum of two crimps with standard industry colors

H. Each connector shall be filled with an oxide-inhibiting compound

I. Crimped with a compression, tool and die system, according to manufacturer’s recommendation

2.06 Taps

A. Connections to the Conductor shall be made with irreversible compression connectors
B. Shall be UL & CSA listed

C. Requires a minimum of (2) crimps for C Tap or H Tap, 1 crimp for I-Beam and busbar Tap

D. Crimp according to manufacturer’s recommendation

Part 3 - Execution

3.01 General

A. Install products in accordance with manufacturer’s recommendations.

B. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

C. Mechanical connections shall be accessible for inspection and maintenance.

D. No insulation shall be installed over mechanical ground connections.

E. Ground connection surfaces shall be cleaned and all connections shall be made so that disconnection or removal is impossible.

3.02 Resistance Measurement

A. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 2 ohms.

3.03 Telecommunications Bonding Backbone (TBB)

A. The intended function of a TBB is to reduce or equalize potential differences between telecommunications systems. While the TBB will carry some current under ac power ground fault conditions, it is not intended to provide the only ground fault return path.

B. The TBB shall:

1. Be connected to each new TGB required in the new IDF closets for the renovations/additions.

2. Be a continuous copper conductor that shall be sized no less than 6 AWG to a maximum of 3/0 AWG. The TBB shall be sized in accordance to the following table:

<table>
<thead>
<tr>
<th>Linear Length – ft.</th>
<th>Size (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 13</td>
<td>6</td>
</tr>
<tr>
<td>14 - 20</td>
<td>4</td>
</tr>
<tr>
<td>21 - 26</td>
<td>3</td>
</tr>
<tr>
<td>27 - 33</td>
<td>2</td>
</tr>
<tr>
<td>34 - 41</td>
<td>1</td>
</tr>
<tr>
<td>42 - 52</td>
<td>1/0</td>
</tr>
<tr>
<td>53 - 66</td>
<td>2/0</td>
</tr>
<tr>
<td>Greater than 67’</td>
<td>3/0</td>
</tr>
</tbody>
</table>
3. The TBB conductors shall be installed and protected from physical and mechanical damage.

4. The TBB conductors should be installed without splices.
   a. Where splices are necessary, the number of splices should be kept to a minimum and they shall be accessible and located within telecommunications spaces or j-box labeled as a telecommunications bonding backbone splice.
   b. Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors or equal.

C. A metallic cable shield shall not be used as a TBB.

3.04 Grounding Equalizer (GE)

A. The GE shall be a continuous copper conductor that shall be sized no less than 6 AWG to a maximum of 3/0 AWG. The GE shall match the size of the TBB.

B. The GE shall connect to the telecommunications grounding busbar(s) in the same-floor telecommunications rooms on the first, top, and every third floor in a building greater than 4 floors.

C. A metallic cable shield shall not be used as a GE.

3.05 Telecommunications Equipment Bonding Conductor (TEBC)

A. Connects the TGB to equipment racks and cabinets.

B. Shall be a continuous copper conductor that shall be sized per the length of cable.

C. Shall be separated from ferrous materials by 2" or be bonded to the ferrous metal.

D. May be routed within cable trays or suspended 2" under or off the side of the cable tray or ladder rack.

E. Shall be supported every 3ft.

F. 8" minimum bend radius.

G. May come cross other cable groups at a 90 degree angle only.

H. A metallic cable shield shall not be used as a TEBC.

3.06 Rack or Cabinet Bonding Conductor

A. A bonding conductor shall be used to connect the equipment racks and cabinets directly to the TMGB, TGB or underfloor ground mesh network.

B. All metallic enclosures, including remote mounted equipment cabinets and racks for telecommunications, security or audio/visual shall be bonded to the nearest TMGB or TGB using a minimum sized conductor of 6 AWG. Remote bonds shall be labeled on both ends stating the destination of the bond.
3.07 Electrical Distribution Panel (EDP)
   A. The AC EDP serving the Telecommunications Room shall be bonded to the TGB using a minimum of a 6 AWG cable.
   B. A qualified electrician shall make all connections within an AC electrical distribution panel.

3.08 Optical Fiber Conductive Cables
   A. Conductive fiber-optic cables should be bonded and grounded as specified in the NEC.

3.09 Conduit and Sleeve Bonding
   A. All conduits and sleeves entering a telecommunications room shall be grounded.

3.10 Ladder Rack and/or Cable Tray
   A. All low voltage cable runway sections shall be bonded together and bonded back to the nearest Telecommunications Room the runway is serving as close TMGB or TGB as practical.
   B. Maintain an 8” minimum bend radius on the TEBC.
   C. Keep a 2” separation from other cables both power and telecommunications.
   D. Remove any paint, oxidation, etc. from the runway surfaces that are being bonded.
   E. Drill two holes as required to accommodate the 2-hole compression lug.
   F. Apply a thin coat of antioxidant around the holes and on the surface where the lug will be in contact.
   G. Attach straps to the runway using stainless steel hardware sized for the lug holes.
   H. Wipe off any excess antioxidant after installation of the lug.

3.11 Building Steel
   A. Each ground bus bar shall be bonded to building steel.
   B. Remove any paint or fire stopping spray from the building steel.
   C. Provide the appropriate bonding connector to connect to beams, trusses or other types of structure.

3.12 Labeling
   A. Each grounding/bonding cable shall be labeled at the TGB.
   B. All taps to the TBB shall be within an enclosure and labeled as to its purpose.
   C. Mechanical connectors shall be clearly marked with the catalog number, conductor size, and manufacturer.
   D. Compression lugs shall be clearly marked with manufacturer, catalog number, conductor size, and required compression tool settings.
3.13 Testing
   A. Refer to Section 27 00 00 for additional requirements.
   B. Perform testing in accordance with test instrument manufacturer’s recommendations using the fall-of-potential method.

3.14 Training
   A. Refer to Section 27 00 00 for additional requirements.

3.15 Warranty
   A. Refer to Section 27 00 00 for additional requirements.

End of Section
SECTION 27 11 00 COMMUNICATIONS EQUIPMENT ROOMS

Part 1 - General

1.01 Scope

A. Refer to Section 27 00 00 for additional project scope information.

B. This section describes the products and execution requirements relating to telecommunications cabling, termination components, racks, pathways, telecommunication rooms and related subsystems. Covered systems include the following:

1. Equipment room cable management system and equipment racks
2. Horizontal and backbone cable terminating equipment
3. Telecommunications grounds and related components

1.02 Related Work

A. Section 27 00 00 – General Technology Requirements
B. Section 27 05 00 – Communications General Requirements
C. Section 27 05 23 – Pathways for Technology Systems
D. Section 27 05 26 – Grounding and Bonding for Technology Systems
E. Section 27 13 00 – Communications Backbone Cabling
F. Section 27 15 00 – Communications Horizontal Cabling
G. Section 27 16 00 – Communications Connecting Cords
H. Section 27 18 00 – Communications Labeling and Identification
I. Section 27 51 00 – Distributed Communications Systems
J. Section 27 60 00 – Physical Security General Requirements
K. Section 27 62 00 – Electronic Access Control System
L. Section 27 64 00 – Video Surveillance System
M. Section 27 66 00 – Intrusion Detection System

1.03 Definitions

A. Refer to Section 27 00 00 for additional definitions.

1.04 Reference Standards and Codes

A. Refer to Section 27 00 00 for additional requirements.

1.05 Qualifications

A. Refer to Section 27 00 00 for additional requirements.
1.06 Pre-Construction Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.07 Construction Progress Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.08 Closeout Submittals
   A. Refer to Section 27 00 00 for additional requirements.

Part 2 - Products

2.01 Substitutions
   A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Category 6 Patch Panels
   A. Cables shall be terminated at the telecommunication closets on high-density integrated patch panels incorporating Category 6 jacks (non-keyed 8-pin), meeting the specifications for the telecommunications outlet detailed in the section above.
   B. Patch panel configuration shall be 48 ports.
   C. The patch panel shall exceed ANSI/TIA/EIA 568-C.2-1 Category 6 component compliance standard. All pair combinations shall be considered, with the worst-case measurement being the basis for compliance.
   D. The patch panels shall be interoperable and backwards compatible to lower performing cabling systems.
   E. Panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers’ minimum bend radius specifications are adhered to.
   F. The patch panel shall have color-coded designation strips to identify cable count.
   G. Manufacturers:
      1. Panduit DP24688TGY 24-Port Category 6 Patch Panel
      2. Panduit DP48688TGY 48-Port Category 6 Patch Panel

2.03 Category 6a Patch Panels
   A. Cables shall be terminated at the telecommunication closets on high-density integrated patch panels incorporating Category 6a rated jacks (non-keyed 8-pin), meeting the specifications for the telecommunications outlet detailed in the section above.
   B. Patch panel configuration shall be 48 ports.
   C. Wireless access points shall be installed on their own dedicated patch panel at the top of the rack.
D. The patch panel shall exceed ANSI/TIA/EIA 568-C.1 Category 6a compliance standard. All pair combinations shall be considered, with the worst-case measurement being the basis for compliance.

E. The patch panels shall be interoperable and backwards compatible to lower performing cabling systems.

F. Panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers’ minimum bend radius specifications are adhered to.

G. The patch panel shall have color-coded designation strips to identify cable count.

H. Manufacturers:
   1. Panduit DP246X88TGY 24-Port Category 6A Patch Panel
   2. DP486X88TGY 48-Port Category 6A Patch Panel

2.04 Voice Patch Panels

A. At each IDF the voice backbone cables originating from the primary distribution point shall be terminated on rack mounted voice patch panels.

B. Backbone cables 25-pair or less shall be terminated on 24-port patch panels and backbone cables greater than 25-pair shall be terminated on 48-port patch panels.

C. The voice patch panel shall utilize 25-pair Amphenol connectors on the rear and RJ-45 jacks on the front.

D. Manufacturers:
   1. Panduit

2.05 Fiber Optic Patch Panels

A. The Contractor shall provide a fiber optic patch panel at each location where a fiber optic cable terminates.

B. All terminated fibers shall be mated to duplex LC couplings mounted on enclosed patch panels. Couplers shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types, including SC, ST, Fixed Shroud Duplex (e.g., “FDDI Connector”), Biconic, and FC by changing panels on which connector couplings are mounted.

C. The patch panel enclosure shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and Drawings, including those not terminated (if applicable), PLUS 50% future growth.

D. The Contractor shall provide all required connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated.

E. Patch panels shall be designed for easy installation, front removal, and expansion of snap-in adapter panels.
F. Patch panels shall be enclosed assemblies affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to protect the connector couplings and fiber optic jumpers.

G. The patch panel’s enclosure shall provide for strain relief of incoming cables and shall incorporate radius control mechanisms to limit bending of the fiber to the manufacturer’s recommended minimums or 1.2", whichever is larger.

H. Access to the inside of the patch panel enclosure during installation shall be from the front and rear. Panels that require any disassembly of the cabinet to gain entry will not be accepted.

I. All patch panels shall provide protection to both the “facilities” and “user” side of the coupling. The patch panel enclosure shall be configured to require front access only when patching. The incoming cables (backbone, riser, etc.) shall not be accessible from the patching area of the panel. The enclosure shall provide a physical barrier to access of such cables.

J. Where singlemode fibers are installed, the fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies (“pigtails”) or (2) use of a “fan-out” kit. In the latter approach, individual fibers are to be secured in a protective covering (such as an Aramid reinforced tube, for example) with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the “fusion” method. Individual splice loss shall not exceed 0.2 dB.

K. Fiber optic patch panels shall be Panduit in IDF.

L. 50-micron LC adaptor panels shall be Panduit.

M. Singlemode LC adaptor panels shall be Panduit.

2.06 Cable Management System

A. The cable management system shall be used to provide a neat and efficient means for routing and protecting fiber and copper cables and patch cords on telecommunication racks and enclosures. The system shall be a complete cable management system comprising 4-post and 2-post floor mount racks, wall mount racks, equipment cabinets and vertical and horizontal cable managers to manage cables on both the front and rear of the rack. The system shall protect network investment by maintaining system performance, controlling cable bend radius, and providing cable strain relief.

1. 4-Post Equipment Racks
   a. The Contractor shall provide and install 4-post adjustable equipment racks to house cable termination components (e.g., copper data and fiber optic) and network electronics (by others) as shown on the Drawings. Prior to installation, the Contractor shall coordinate exact placement with Consultant and Owner.
   b. Rack shall be 84" in height and shall be self-supporting.
   c. Channel uprights shall be spaced to accommodate industry standard 19" mounting.
   d. Rack shall be constructed of aluminum.
   e. Rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole
pattern on rack front shall be per EIA/TIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.

f. Rack shall be supplied with at least 24 spare screws.

g. Rack shall be supplied with a vertical ground bar and #6 AWG ground lug.

h. Manufacturers:
   i. Panduit

2. 4-Post Server Racks

   a. The Contractor shall provide and install 4-post adjustable server racks to house cable termination components (e.g., copper data and fiber optic), network electronics (by others) and servers as shown on the Drawings. Prior to installation, the Contractor shall coordinate exact placement with Consultant and Owner.

   b. Rack shall be 84" in height and shall be self-supporting.

   c. Channel uprights shall be spaced to accommodate industry standard 19" mounting.

   d. Rack shall be constructed of aluminum.

   e. Rack shall be double side drilled and tapped to accept square-punched .375" equipment mounting holes. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per EIA/TIA specifications (5/8"-5/8"-1/2").

   f. Rack shall be supplied with at least 24 spare screws.

   g. Rack shall be supplied with ground lugs.

   h. Provide with cable waterfall and vertical cable managers

   i. Contractor shall provide 100 cage nuts and screws with each rack.

   j. Manufacturers:
      i. Panduit

3. 2-Post Equipment Racks

   a. The Contractor shall provide and install 2-post adjustable equipment racks to house cable termination components (e.g., copper data and fiber optic) and network electronics (by others) as shown on the drawings. Prior to installation, the Contractor shall coordinate exact placement with Owner.

   b. Rack shall be 84" in height and shall be self-supporting.

   c. Channel uprights shall be spaced to accommodate industry standard 19" mounting and have pass-through holes with smooth edges to protect cables.

   d. Rack shall be constructed of aluminum.

   e. Able to support up to 1,500 pounds.

   f. Rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per EIA/TIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
g. Rack shall be supplied with at least 24 spare screws.

h. Rack shall be supplied with a vertical ground bar and #6 AWG ground lug.

i. Manufacturers:
   i. Panduit

B. Vertical Cable Management

1. At the telecommunication rooms, vertical cable management shall be furnished and installed to adjacent racks to organize cables on front and rear of telecommunication racks.

2. Vertical cable managers shall include components that aid in routing, managing, and organizing cable to and from equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a universal design mounting to EIA 19” or 23” racks.

3. Vertical cable management system shall feature the following:
   a. Open cabling section on the rear that provides easy access and routes cable bundles feeding into the back of patch panels and 1 RMU cable guide on the front designed for fanning and managing patch cords.
   b. Edge-protected pass-through ports designed for easy routing of cable from front channel to back.
   c. Vertical slots along the center separator to allow securing cable bundles neatly with management straps.
   d. Door/cover (front only) that is easily opened from the right or left and still easily removed to allow for quick moves, adds, and changes.
   e. Movable wire retainers to retain the cables during cover removal.

4. Vertical cable management at the end of rack rows shall be 6”.

5. Vertical cable management between racks shall be 10”

6. Manufacturer:
   a. Panduit

2.07 Power Devices

A. Refer to Section 27 00 00 for additional requirements.

B. Horizontal PDU, Single Circuit

1. Power strip shall provide 3,840 joules of surge protection and power conditioning.

2. Contractor shall provide one (1) power strip per rack/cabinet.

3. Power strip shall be rated for 20 amps.

4. Manufacturer:
   a. Tripp-Lite IBAR12-20ULTRA
b. Or approved equal

C. Vertical PDU, Dual Circuit

1. Contractor shall provide one (1) power strip per server rack/cabinet.
2. Dual NEMA L5-20R or 5-20R (with included adapter) receptacle connections.
3. Single-Phase, Dual 20A Circuits, 3.8kW
4. 16 color coded outlets per circuit
5. Dual digital meters displaying amps.
6. Provide with appropriate rack mounting hardware.
7. Manufacturer:
   a. Tripp-Lite PDUMV40
   b. Or approved equal

2.08 Wall Mount Equipment Cabinet

A. Where indicated on Project Drawings, the Contractor shall provide and install wall mount cabinet to house cable termination panels and network electronics. The Contractor shall also provide and install one (1) ¾” plywood backboard for support when mounting cabinet.

B. The Contractor shall coordinate with Electrical Contractor to install a power outlet into cabinet.

C. Cabinets shall be equipped with fans and thermostatic fan controller.

D. Manufacturers:

   1. Panduit

2.09 Horizontal Cable Management

A. Horizontal cable managers shall include components that aid in routing, managing, and organizing cable to and from equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a universal design mounting to EIA 19" racks and constructed of steel bases with PVC duct attached. The duct fingers shall include retaining tabs to retain the cables in place during cover removal. The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.

B. The cable managers shall be provided with movable wire retainers to retain the cables during cover removal and #12-24 mounting screws. An integral strain relief bracket shall be provided on either end of the duct to allow for easy cover placement.

C. Double-Sided horizontal cable managers shall be placed above and below each patch panel.

D. The Contractor shall also supply (1) per 48-port patch panel additional managers for network electronics.

E. Manufacturers:
1. Panduit

2.10 Telecommunication Ground

A. The Telecommunication Contractor is responsible for providing an appropriate ground for all racks, trays, and telecommunications equipment installed by this Contractor. Refer to the Grounding and Bonding for Technology Systems specification section.

2.11 Wire Basket Runway Tray

A. Within each Telecommunications Room, the Contractor shall provide and install sufficient wire basket tray to support cable bundles from corridor to equipment racks or as shown on the Project Drawings, this Contractor shall provide and install sufficient basket tray to support cable bundles from corridor to equipment racks or cabinets.

B. The Contractor shall provide all necessary labor, supervision, materials, equipment, tests, and services to install complete wire basket runway systems in the telecommunication closet.

C. Wire basket runway systems shall include, but are not limited to, straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports, and accessories.

D. Specifications and Drawings are for assistance and guidance, but exact routing, locations, distances, and levels will be governed by actual field conditions.

E. All straight section longitudinal wires shall be straight (with no bends).

F. Wire basket runway shall be made of high strength steel wires and formed into a standard 2-inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along runway sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

G. All fittings shall be field formed as needed.

H. All splicing assemblies shall be the bolted type using serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 stainless steel. Splicing assemblies shall provide a continuous ground connection.

I. Wire Basket Tray shall be grounded to a Telecommunications Room ground bus bar.

J. Cable Drop Out/Waterfall

1. Where cables bundles transition from tray and drop to the rack, cabinets or ladder rack, the Contractor shall provide and install a radius control device. This device shall be a waterfall or drop out device and shall be properly sized to accommodate cable bundle plus 20% future growth.

K. T-sections of tray shall be made using T-section fittings.

L. Straight section splices shall be made using splice plates.

M. Wire basket runway supports shall be wall mounted brackets and trapeze hangers when spanning the room.

N. Trapeze hangers shall be supported by 3/8 inch diameter rods.

O. Provide size as indicated on the drawings.
P. Tray shall have flat Black finish.

Q. Accessories (connectors, splice plates…) shall be painted to match tray finish.

R. Manufacturer:
   1. Cooper B-Line
   2. Legrand Cablofil
   3. Pentair Hoffman
   4. Or approved equal

2.12 Ladder Rack

A. Within each Telecommunications Room, the Contractor shall provide and install ladder rack as shown on the Project Drawings.

B. Within each Telecommunications Room with a vertical conduit riser the Contractor shall provide and install vertical ladder rack connecting the ground conduit sleeve penetrations with the ceiling conduit sleeve penetrations.

C. The Contractor shall provide all necessary labor, supervision, materials, equipment, tests, and services to install a complete ladder rack system in the telecommunications room as shown on the Drawings.

D. Specifications and Drawings are for assistance and guidance, but exact routing, locations, distances, and levels will be governed by actual field conditions.

E. All splicing assemblies shall be the bolted type using serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 stainless steel.

F. Cable Drop Out/Waterfall
   1. Where cables bundles transition from tray and drop into the racks/cabinets, the Contractor shall provide and install a radius control device. This device shall be a waterfall or drop out device and shall be properly sized to accommodate cable bundle plus 20% future growth.

G. Size ladder rack as indicated on the Contract Documents.

H. Accessories (connectors, splice plates…) shall be painted to match tray finish.

I. Manufacturers:
   1. Chatsworth
   2. Cooper
   3. Legrand
   4. Pentair Hoffman
   5. Or approved equal
Part 3 - Execution

3.01 Testing
   A. Refer to Section 27 00 00 for additional requirements.

3.02 Training
   A. Refer to Section 27 00 00 for additional requirements.

3.03 Warranty
   A. Refer to Section 27 00 00 for additional requirements.

3.04 Equipment Rack and Cabinets
   A. Prior to permanently securing racks or cabinets, the Contractor shall coordinate a walk through with the Owner to determine exact placement of racks.

   B. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. Rack shall also be stabilized by extending a brace extending to the wall. Alternately, overhead cable tray over which the cabling accesses the equipment rack(s) shall provide this function.

   C. A space between the rack upright and the wall (~6") shall be planned to allow for cabling in that area. The rear of the rack shall be ~40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed shall be brought to the attention of the Consultant for resolution prior to installation.

   D. All hardware and equipment is to be mounted at least 18" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware shall be reviewed and approved by the Consultant and Site Coordinator(s) prior to installation.

   E. Equipment rack shall be equipped with cable management hardware to allow an orderly and secure routing of twisted pair cabling to the data patch panels. At minimum, one such horizontal jumper management panel shall be placed below each fiber optic patch panel installed by the Contractor. Additional jumper management panels may be required pending installation of other cable types on the rack. The rack shall be grounded to the telecommunications grounding backbone (TGB) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket).

3.05 Wire Basket Tray and Ladder Rack Runway
   A. Runway shall be installed in accordance with recognized industry practices, to ensure that the cable tray equipment complies with requirements of NEC, applicable portions of NFPA 70B and NECA’s “Standards of Installation” pertaining to general electrical installation practices.

   B. Coordinate installation of runway with other electrical work as necessary to properly interface installation of wire basket runway with other work.

   C. Provide sufficient space encompassing runways to permit access for installing and maintaining cables.
D. Test runways to ensure electrical continuity of bonding and grounding connections and to
demonstrate compliance with specified maximum grounding resistance.

End of Section
SECTION 27 13 00  COMMUNICATIONS BACKBONE CABLING

Part 1 - General

1.01  Scope

A. Refer to Section 27 00 00 for additional project scope information.

B. This section describes the products and execution requirements relating to telecommunications voice, data and video backbone cabling and termination components.

C. Backbone Cabling is the cable and hardware interconnecting telecommunication rooms (TRs), building demarcation rooms, equipment rooms and server rooms. The backbone cabling shall consist of the following cable types:
   1. 50-micron Multimode Fiber Optic Cable
   2. Singlemode Fiber Optic Cable
   3. Multi-Pair Copper Voice Backbone Cable

D. This project will contain new IDF closets. Backbone Cabling will be required at these locations from each schools existing MDF.

1.02  Related Work

A. Section 27 00 00 – General Technology Requirements
B. Section 27 05 00 – Communications General Requirements
C. Section 27 05 23 – Pathways for Technology Systems
D. Section 27 05 26 – Grounding and Bonding for Technology Systems
E. Section 27 11 00 – Communications Equipment Rooms
F. Section 27 15 00 – Communications Horizontal Cabling
G. Section 27 16 00 – Communications Connecting Cords
H. Section 27 18 00 – Communications Labeling and Identification

1.03  Definitions

A. Refer to Section 27 00 00 for additional definitions.

1.04  Reference Standards and Codes

A. Refer to Section 27 00 00 for additional requirements.

1.05  Qualifications

A. Refer to Section 27 00 00 for additional requirements.

1.06  Pre-Construction Submittals

A. Refer to Section 27 00 00 for additional requirements.
1.07 Construction Progress Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.08 Closeout Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.09 Test Data – Fiber Optic Media
   A. The test result information for each link shall be recorded in the memory of the field tester upon completion of the test.

   B. The test result records saved by the tester shall be transferred into a Windows-based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee shall be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test.

   C. The database for the completed job shall be stored and delivered on CD-ROM. This CD-ROM shall include the software tools required to view, inspect, and print any selection of test reports.

   D. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:

      1. The identification of the link in accordance with the naming convention defined in the overall system documentation.

      2. The overall Pass/Fail evaluation of the link-under-test including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value as defined in this document).

      3. The date and time the test results were saved in the memory of the tester.

   E. The following general information is to be provided in the electronic database containing the test result information for each link:

      1. The identification of the customer site as specified by the end user.

      2. The overall Pass/Fail evaluation of the link-under-test.

      3. The name of the standard selected to execute the stored test results.

      4. The cable type and the value of the 'index of refraction' used for length calculations.

      5. The date and time the test results were saved in the memory of the tester.

      6. The brand name, model, and serial number of the tester.

      7. The revision of the tester software and the revision of the test standards database in the tester.

   F. The detailed test results data to be provided in the electronic database for each tested optical fiber shall contain the following information:

      1. The identification of the link/fiber in accordance with the naming convention defined in the overall system documentation.
2. The insertion loss (attenuation) measured at each wavelength, the test limit calculated for the corresponding wavelength, and the margin (difference between the measured attenuation and the test limit value).

G. The link length shall be reported for each optical fiber for which the test limit was calculated.

H. Contractor shall provide accurate as-built Construction Drawings at the site during construction.

I. The Drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (".dwg", AutoCAD rel. 2004 and ".dxf") formats on which as-built construction information can be added. These documents will be modified accordingly by the Contractor to denote as-built information as defined above and returned to the Owner.

J. The Contractors shall annotate the base Drawings and return to the Consultant in hard copy (same plot size as originals) and electronic (AutoCAD rel. 2004 and ".dxf") form.

Part 2 - Products

2.01 Substitutions

A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Backbone Voice Cabling

A. The voice backbone cable shall link the Main Closet and Telecommunications Rooms serving the building. The cables shall be CMP rated where required.

B. Voice backbone cable shall incorporate 24 AWG solid annealed copper conductors insulated with a polyvinyl chloride skin over expanded polyethylene. Conductors shall be twisted to form pairs and fully color-coded.

C. The voice backbone cable shall be sized as detailed on the Drawings.

D. Conductors shall be identified by the insulation color of each conductor. The color code shall follow the industry standard composed of ten (10) distinctive colors to identify 25 pairs in accordance with ICEA publication S-80-576-1988. Marking of each mate of the primary conductor in a pair with the color of that primary conductor is optional.

E. The voice backbone cable shall meet or exceed the EIA/TIA Category 3 performance requirements.

F. When cables of larger than 25 pairs are required, the core shall be assembled into 25-pair subunits, each color-coded in accordance with ICEA publication S-80-576-1988. Cables with over 600 pairs shall have 25-pair binder groups combined into super units. These super units shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow, and violet. Binder color code integrity shall be maintained wherever cables are spliced.

G. All cables and equipment shall be furnished, installed, wired, and tested by the Contractor.

H. Manufacturers:
1. Panduit

2.03 Tight-Buffered Optical Fiber Cables for Indoor Distribution Applications

A. General Considerations

1. The cable shall meet the requirements of the National Electrical Code (NEC) Section 770.
2. For plenum applications, the cable shall meet applicable flame tests: ANSI/UL 910 (NFPA 262-1994).
3. Finished cables shall conform to the applicable performance requirements of Tables 8-6 and 8-7 of the Insulated Cable Consultants Association, Inc. (ICEA) Standard for Fiber Optic Premises Distribution Cable (ICEA S-83-596).

B. Cable Construction

1. The coated fiber shall have a layer of Teflon placed between the acrylate coating of the optical fiber and the thermoplastic buffer. The diameter of the thermoplastic buffer coating shall be 900 ±50µm. The fiber coating and buffer shall be removable with commercially available stripping tools in a single pass for connectorization or splicing.
2. Cables with 2 to 24 fibers layered aramid yarns shall serve as the tensile strength member of the cable.
3. A ripcord shall be applied between the aramid yarns and the outer jacket to facilitate jacket removal.
4. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness. The jacket shall be smooth, as is consistent with the best commercial practice.
5. The fibers shall be stranded around a dielectric central member.
6. For cables containing 12-24 fibers, the fibers shall be arranged in two layers.
7. The central member shall be over coated with a thermoplastic, when required, to achieve dimensional sizing to accommodate and support the 900 µm buffered fibers.
8. Cables with 24 to 60 fibers shall have unitized riser and plenum constructions.
9. The buffered fibers shall be grouped in six-fiber subunits.
10. The fibers shall be stranded around a dielectric central member in the subunit.
11. Layered aramid yarns shall serve as the tensile strength member of the subunit.
12. A ripcord may be applied between the aramid yarns and the subunit jacket to facilitate jacket removal.
13. The subunit jacket shall be extruded over the aramid yarns for physical and environmental protection. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness. The jacket shall be smooth, as is consistent with the best commercial practice.
14. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be
extruded around the subunits. The strength members shall be of a high modulus aramid yarn. The aramid yarns shall be helically stranded around the buffered fibers. Non-toxic, non-irritant talc shall be applied to the yarns to allow them to be easily separated from the fibers and the subunit jacket.

C. Outer Cable Jacket

1. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand stresses. The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, and environmental test requirements of this document over the life of the cable.

2. The indoor distribution cable specified herein shall have an interlocking armor made of steel or aluminum. Provide plenum rated cable as required.

3. The indoor distribution cable specified herein shall be non-conductive. Provide plenum rated cable as required.

4. The color of the jacket shall match the jacket color of the optical fiber cable located inside of the cable.

D. Fiber Identification

1. The individual fibers shall be color-coded for identification. The optical fiber color-coding shall be in accordance with ANSI/TIA/EIA-598-B “Optical Fiber Cable Color Coding.” The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color-coded buffered fibers shall not adhere to one another.

2. When buffered fibers are grouped into individual subunits, each subunit jacket shall be numbered for identification, with the exception of filler subunits where used. The number shall be repeated at regular intervals. The subunit jacket color shall be aqua for subunits containing OM3/4 multimode fibers, yellow for subunits containing singlemode fibers, and white for filler subunits.

3. The outer jacket for all dielectric cable shall be marked with the manufacturer name or UL file number, date of manufacture, fiber type, flame rating, listing symbol, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket. The cable jacket color shall be Aqua for cables containing OM3/4 multimode fibers and yellow for cables containing singlemode fibers.

4. Cables shall be marked with the manufacturer name, date of manufacture, fiber type, flame rating, listing symbol, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket. The cable jacket color shall match the color of the core optical fiber cable.

E. Cable Specifications

1. Temperature Range

   a. Non-Plenum Applications: The storage temperature range for the cable on the original shipping reel shall be -40 to +70°C. The installation/operating temperature range for riser cables shall be -20 to +70 °C. Testing shall be in accordance with FOTP-3.

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b. Plenum Applications: The storage temperature range for the cable on the original
shipping reel shall be -40 to +70°C. The installation/operating temperature range for
plenum cables shall be 0 to +70°C. Testing shall be in accordance with FOTP-3.

2. Compressive Load Resistance

a. When tested in accordance with FOTP-41, Compressive Loading Resistance of Fiber
Optic Cables, the cable shall withstand a minimum compressive load of 89 N/cm (50
lbf/in) applied uniformly over the length of the compression plate. While under
compressive load, the fiber shall not experience an attenuation change greater than
0.4 dB at 1550 nm (singlemode) or greater than 0.6 dB at 1300 nm (multimode). After
the compressive load is removed, the fibers shall not experience an attenuation
change greater than 0.2 dB at 1550 nm (singlemode) or greater than 0.4 dB at 1300
nm (multimode).

3. Cyclic Flexing

a. When tested in accordance with FOTP-104, Fiber Optic Cable Cyclic Flexing Test,
the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycle per
minute. The fiber shall not experience an attenuation change greater than 0.2 dB at
1550 nm (singlemode) or greater than 0.4 dB at 1300 nm (multimode).

4. High and Low Temperature Bend

a. When tested in accordance with FOTP-37, Fiber Optic Cable Bend Test, Low and
High Temperature, the cable shall withstand four full turns around a mandrel at test
temperatures of 0 ºC and +50 ºC. The fibers shall not experience an attenuation
change greater than 0.2 dB at 1550 nm (singlemode) or greater than 0.5 dB at 1300
nm (multimode).

5. Impact Resistance

a. When tested in accordance with FOTP-25, Repeated Impact Testing of Fiber Optic
Cables and Cable Assemblies, the cable shall withstand a minimum of 20 impact
cycles for riser cables and 10 impact cycles for plenum cables. The fibers shall not
experience an attenuation change greater than 0.2 dB at 1550 nm (singlemode) or
greater than 0.4 dB at 1300 nm (multimode).

6. Temperature Cycling

a. When tested in accordance with FOTP-3, Procedure to Measure Temperature
Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic
Components, the change in attenuation at extreme operational temperatures (0 to
+50 ºC) shall not exceed 0.3 dB/km at 1550 nm (singlemode) or 0.6 dB/km at 1300
nm (multimode). The change in attenuation is measured with respect to the baseline
values measured at room temperature before temperature cycling.

7. Twist-Bend

a. When tested in accordance with FOTP-91, Fiber Optic Cable Twist-Bend Test, a
length of cable no greater than 2 meters shall withstand 10 cycles of mechanical
twisting and bending around a mandrel 20 times the cable outer diameter. The fibers
shall not experience an attenuation change greater than 0.2 dB at 1550 nm
(singlemode) or 0.4 dB at 1300 nm (multimode).

F. Service Loop

1. Each fiber optic cable shall have a 10’ service loop properly secured above the ceiling.
G. Multimode OM4 (50/125 µm)

1. The multimode fiber utilized in the optical fiber cable shall meet EIA/TIA-492AAAA-A-1997, Detail Specification for 50µm Core Diameter/125µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers, unless noted otherwise. Cable shall have the following specifications:
   a. Core Diameter: 50 ± 3 µm
   b. Core Non-Circularity: ≤5%
   c. Cladding Diameter: 125± 2 µm
   d. Cladding Non-Circularity: <2.0%
   e. Core-to-Cladding Concentricity: ≤ 3 µm
   f. Coating Diameter: 245 ± 2 mm
   g. Refractive Index Profile: Graded index
   h. Numerical Aperture: 0.275 ± 0.015
   i. Maximum Attenuation: less than 3.0 dB/km at 850 nm and 1.0 dB/km at 1300 nm.

2. IEEE 802.3ae Performance: The fiber shall support laser-based 10 Gigabit Ethernet (10GbE) operation for up to 550 meters.

3. Attenuation at the Water Peak: The attenuation coefficient at 1380 nm shall not exceed the attenuation coefficient at 1300 nm by more than 1.0 dB/km.

4. Macrobend Attenuation: The attenuation due to 100 turns of fiber around a 75± 2 mm diameter mandrel shall not exceed 0.5 dB at 850 nm or 1300 nm.

H. Singlemode OS2

1. The singlemode fiber utilized in the optical fiber cable shall meet EIA/TIA-492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Singlemode Optical Fibers, and ITU recommendation G.652, Characteristics of Singlemode Optical Fiber Cable. The cable shall meet the following specifications:
   a. Core Diameter (Characterized): 8.3 µm
   b. Cladding Diameter: 125. ±1.0µm
   c. Core-to-Cladding Concentricity: ≤ 0.8 µm
   d. Cladding Non-Circularity: ≤1.0 %
   e. Coating Diameter: 245 ±10µm

2. Attenuation: The maximum attenuation shall be 0.5 dB/km at 1310 nm and 0.4 dB/km at 1550 nm.

3. Attenuation Uniformity: There shall be no point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.

4. Attenuation at the Water Peak: The attenuation at 1383 ± 3 nm shall not exceed 2.1dB/km.
5. Cutoff Wavelength: The cabled fiber cutoff wavelength shall be ≤1260 nm.

6. IEEE 802.3z Performance: The fiber shall support laser-based Gigabit Ethernet (1GbE) operation in the 1000BASE-LX (1310 nm) operating window at 10000 m.

7. IEEE 802.3ae Performance: The fiber shall support laser-based Gigabit Ethernet (10GbE) operation in the 10000BASE-LX (1310 nm) operating window at 10000 m.

8. IEEE 802.3ba Performance: The fiber shall support laser-based Gigabit Ethernet (40/100GbE) operation in the 40000/100000BASE-LX (1310 nm) operating window at 10000 m.

9. Mode Field Diameter: The mode field diameter of the fiber shall be 9.30 ±0.50µm at 1310 nm 10.50 ±1.0µm at 1550 nm.

10. 12 Macrobend Attenuation: The attenuation due to 100 turns of fiber around a 75-± 2mm diameter mandrel shall not exceed 0.05 dB at 1310 nm and 0.10 dB at 1550 nm.

11. Zero Dispersion Wavelength ($\partial_o$): The zero dispersion wavelength of the fiber shall be $1301.5 \text{ nm} \leq \partial_o \leq 1321.5 \text{ nm}$.

12. Zero Dispersion Slope (So): The zero dispersion slope of the fiber shall be ≤0.092 ps/(nm•km).

13. Maximum Dispersion: The maximum dispersion shall be ≤3.2 ps/(nm•km) from 1285 nm through 1330 nm and shall be ≤18 ps/(nm•km) at 1550 nm.

I. The cable shall be manufactured by:
   1. Panduit

2.04 Loose Tube Optical Fiber Cables for Outside Plant Distribution Applications

A. The cable shall be all-dielectric gel-free designed for outdoor and limited indoor use for campus backbones in lashed aerial and duct installations.

B. The cable shall be fully waterblocked using water-swellable materials.

C. The outer sheath shall be marked with the manufacturer’s name, words identifying the cable type (e.g. "Optical Cable" or "Fiber Optic Cable"), year of manufacture, and sequential length markings. The actual length of the cable shall be within -0/+1% of the length markings. The marking shall be in a contrasting color to the cable jacket.

D. Temperature Range:
   1. Storage: -40 to +70°C (no irreversible change in attenuation)
   2. Operating: -40 to +70°C
   3. Humidity Range: 0 to 100%

E. F. Maximum Tensile Strength:
   1. During Installation: 2700 Newton (600 lb. force) (no irreversible change in attenuation)
   2. Long Term: 890 N (200 lb. force)

F. G. Bending Radius:
1. During Installation: 20 times cable diameter
2. No Load: 10 times cable diameter

G. The maximum pulling tension shall be 2700 N (608 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

H. The cable shall be manufactured by:
   1. Panduit

I. Single Mode Optical Fiber Performance
   1. The single mode fiber shall be dispersion-unshifted, fiber which meets the ITU-T G.652c requirements.
   2. The fiber cable shall be fully capable of handling existing and legacy singlemode applications which traditionally operate in the 1310nm and 1550nm regions.
   3. The fiber cable shall be designed to handle applications that utilize the "Extended" E band, 1360-nm to 1460 nm.
   4. The fiber cable shall also be designed to provide optimum performance from 1265nm to 1625nm making it suitable for 16-channel Course Wavelength Division Multiplexing applications.
   5. The fiber shall meet the following specifications:
      a. Fiber Type Single mode; doped silica core surrounded by a concentric glass cladding.
      b. Core Diameter: 8-9 µm. All fibers shall be of the same nominal core diameter and profile.
      c. Cladding Diameter: 125 + 0.7 micron
      d. Core-to-Cladding Offset: < 0.5 micron
      e. Cladding Non-Circularity: < 1.0%
      f. Coating Diameter: 245 + 10 micron
      g. The coating shall be mechanically strippable without damaging the optical fiber.
      h. Cutoff Wavelength (cabled fiber; ccf)<1260-nm
      i. Mode field diameter: 9.2+0.4 micron at 1300-nm; 10.4+0.5 micron at 1550 -nm
      j. Zero Dispersion Wavelength: 1302< < 1322nm
      k. Zero Dispersion Slope (S0): <0.092 ps/nm2*km
      l. Fiber Attenuation:
         i. 1383-nm 0.4 dB/km
         ii. 1550-nm 0.3 dB/km
         iii. The average change in attenuation at extreme operational temperature (40 C to +70 C) shall not exceed 0.05 dB/km at 1550 nm. The magnitude of the maximum

080320
attenuation change of each individual fiber shall not be greater than 0.05 dB/km at 1550 nm.

m. Fiber Dispersion (maximum):
   i. 1285-1330-nm < 3.2-ps/nm*km
   ii. 1625-nm < 22-ps/nm*km

n. 14. No single mode optical fiber shall show a point discontinuity greater than 0.03 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that fiber by the Owner.

2.05 Fiber Optic Connectors

A. The MM optical connector shall be LC UPC type.
B. The SM optical connector shall be LC UPC type.
C. The OSP MM optical connector shall be SC UPC type.
D. The OSP SM optical connector shall be SC UPC type.
E. The connector ferrule shall be ceramic or glass-in-ceramic. The optical fiber within the connector ferrule shall be secured with an adhesive.
F. The attenuation per mated pair shall not exceed 0.35 dB (individual) and 0.2 dB (average). Connectors shall sustain a minimum of 200 mating cycles per EIA/TIA-455-21 without violating specifications.
G. The connector shall meet the following performance criteria:
   1. Cable Retention (FOTP-6) 0.2 dB
   2. Durability (FOTP-21) 0.2 dB
   3. Impact (FOTP-2) 0.2 dB
   4. Thermal Shock (FOTP-3) 0.2 dB
   5. Humidity (FOTP-5) 0.2 dB
H. Connectors shall be field terminated and polished or fusion spliced. Mechanical, quick connect or index-gel based connectors are not allowed.

Part 3 - Execution

3.01 Testing

A. Refer to Section 27 00 00 for additional requirements.
B. Field Test Requirements for Fiber Optic Cabling System
   1. The fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, the Contractor shall provide cable manufacturer’s test report for each reel of cable provided. These test reports shall include the manufacturers on reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
2. Factory data shall be provided upon request, showing on-the-reel bandwidth performance results as tested at the factory.

3. Every fiber optic backbone link in the installation shall be tested in accordance with the field test specifications defined by the Telecommunications Industry Association (TIA) standard ANSI/TIA/EIA-568-C or by the appropriate network application standard(s), whichever is more demanding.

4. The test shall include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test does not, however, include the performance of the connector at the interface with the test equipment.

5. 100% of the installed cabling links shall be tested and shall pass the requirements of the standards mentioned above and as further detailed in this document. Any failing link shall be diagnosed and corrected at no additional cost to the Owner. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with RFP.

6. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
   a. The manufacturer of the fiber optic cable and/or the fiber optic connectors
   b. The manufacturer of the test equipment used for the field certification
   c. Training organizations authorized by BICSI

7. Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-14-A. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B, Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-C.1) with a Category 1 light source.

8. Field test instruments for singlemode fiber cabling shall meet the requirements of ANSI/EIA/TIA-526-7.

9. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

10. The fiber optic launch cables and adapters shall be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.

11. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests.

12. Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

13. A representative of the Owner shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing begins.

14. A representative of the Owner will select a random sample of 5% of the installed links. The results obtained shall be compared to the data provided by the installation Contractor. If more than 2% of the sample results differ in terms of the Pass/Fail
determination, the installation Contractor, under supervision of the Owner representative, shall repeat 100% of the testing. The cost of retesting shall be borne by the installation Contractor.

C. Fiber Performance Test Parameters

1. The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA standard 568-B.
   a. Link Attenuation = Cable_Attn + Connector_Attn + Splice_Attn
   b. Cable_Attn (dB) = Attenuation_Coefficient (dB/km) * Length (Km)
   c. The values for the Attenuation_Coefficient are listed in the table below:

<table>
<thead>
<tr>
<th>Type of Optical Fiber</th>
<th>Wavelength (nm)</th>
<th>Attenuation_Coefficient (dB/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimode 62.5/125 μm</td>
<td>850</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1.5</td>
</tr>
<tr>
<td>Multimode OM3 50/125 μm</td>
<td>850</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1.5</td>
</tr>
<tr>
<td>Multimode OM4 50/125 μm</td>
<td>850</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1.5</td>
</tr>
<tr>
<td>Singlemode (Inside plant)</td>
<td>1310</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>1550</td>
<td>0.4</td>
</tr>
<tr>
<td>Singlemode (Outside plant)</td>
<td>1310</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>1550</td>
<td>0.5</td>
</tr>
</tbody>
</table>
   d. Connector_Attn (dB) = number_of_connector_pairs * connector_loss (dB)
   e. Maximum allowable mated connectors_loss = 0.50 dB
   f. Splice_Attn (dB) = number of splices (S) * splice_loss (dB)
   g. Maximum allowable splice_loss = 0.1 dB (when tested bidirectionally)

2. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices—i.e., it does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

3. Test equipment that measures the link length and automatically calculates the link loss based on the above formulas is preferred.

4. The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.

5. The backbone link (multimode/singlemode) shall be tested in two directions at both operating wavelengths to account for attenuation deltas associated with wavelength.

6. Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A.

7. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.
8. Multimode backbone links are designed to be used with network applications that use laser light sources (underfilled launch conditions). However, the link attenuation equation has been based upon the use of a light source categorized as Category 1, Overfilled.

9. Singlemode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1. All singlemode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm.

3.02 Training
   A. Refer to Section 27 00 00 for additional requirements.

3.03 Warranty
   A. Refer to Section 27 00 00 for additional requirements.

3.04 Fiber Optic Cable Installation Requirements
   A. Cable slack shall be provided in each backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure.

   B. A minimum of 15 feet of slack cable (each cable) shall be coiled and secured at each end.

End of Section
SECTION 27 15 00  COMMUNICATIONS HORIZONTAL CABLEING

Part 1 - General

1.01  Scope

A. This section describes the products and execution requirements relating to telecommunications voice, data and video horizontal (station) cabling and termination components.

B. Horizontal cabling is the cabling between the work area telecommunications outlet and the telecommunications room (TR). Horizontal cabling is often referred to as “station cabling”.

C. The horizontal cabling system will consist of the following:
   1. Unshielded Twisted Pair (UTP) Cable
   2. Outlet Termination Modules (jacks)
   3. Outlet Termination Plates
   4. Above Ceiling Cable Support Systems
   5. Horizontal Cable Testing Requirements
   6. Cable Pathway/Sleeve Requirements

1.02  Related Work

A. Section 27 00 00 – General Technology Requirements
B. Section 27 05 00 – Communications General Requirements
C. Section 27 05 23 – Pathways for Technology Systems
D. Section 27 05 26 – Grounding and Bonding for Technology Systems
E. Section 27 11 00 – Communications Equipment Rooms
F. Section 27 13 00 – Communications Backbone Cabling
G. Section 27 16 00 – Communications Connecting Cords
H. Section 27 18 00 – Communications Labeling and Identification
I. Section 27 40 00 – AV/Multimedia General Requirements
J. Section 27 41 00 – Audio Visual Systems
K. Section 27 51 00 – Distributed Communications Systems
L. Section 27 60 00 – Physical Security General Requirements
M. Section 27 62 00 – Electronic Access Control System
N. Section 27 64 00 – Video Surveillance System
O. Section 27 66 00 – Intrusion Detection System

1.03 Definitions
   A. Refer to Section 27 00 00 for additional definitions.

1.04 Reference Standards and Codes
   A. Refer to Section 27 00 00 for additional requirements.

1.05 Qualifications
   A. Refer to Section 27 00 00 for additional requirements.

1.06 Pre-Construction Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.07 Construction Progress Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.08 Closeout Submittals
   A. Refer to Section 27 00 00 for additional requirements.

Part 2 - Products

2.01 Substitutions
   A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Cabling Color Schedule
   A. Cables, jacks, and patch cords shall be colored to match their purpose. Confirm colors with Owner prior to pre-construction submittals. Anticipated colors are below.

<table>
<thead>
<tr>
<th>Function</th>
<th>Horizontal Cable</th>
<th>Modular Jack</th>
<th>Patch Cord</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data/Voice</strong> (phone, computer, point of sale, time clock, printer, copier)</td>
<td>BLUE</td>
<td>BLUE</td>
<td>BLUE</td>
</tr>
<tr>
<td><strong>Wireless</strong> (access points)</td>
<td>YELLOW</td>
<td>YELLOW</td>
<td>YELLOW</td>
</tr>
<tr>
<td><strong>Multimedia</strong> (TVs, projectors, AV cabinets)</td>
<td>BLUE</td>
<td>BLUE</td>
<td>BLUE</td>
</tr>
<tr>
<td><strong>Security</strong> (intrusion, access control, video surveillance)</td>
<td>ORANGE</td>
<td>ORANGE</td>
<td>ORANGE</td>
</tr>
</tbody>
</table>
2.03

2.04 Category 6 & 6A Horizontal Copper Cables

A. All cables and equipment shall be furnished, tested, installed and wired by the Contractor.

B. All horizontal data cables shall terminate on modular patch panels in the telecommunications closet as specified on the Drawings.

C. This specification defines the requirements for commercially available high performance Category 6 or 6A cables.

D. This cable shall be suitable for installation free-air, in building risers, in conduit, and/or in cable tray and shall carry CMP rating.

E. The cable design described herein shall exceed transmission performance of Category 6 cables.

F. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code, and meet the specifications of NEMA (low loss), UL 444, and ICEA. Conductor shall also conform to the requirements for solid annealed copper wire in accordance with ASTM B 3.

G. All cables, termination components, and support hardware shall be furnished, tested, installed, and wired by the Contractor.

H. The Contractor shall confirm the jacket colors with the Owner prior to ordering.

I. Each wireless access point shall received two (2) Category 6A drops each.

J. IMPORTANT: Cable and termination components (jack, patch panel, wiring blocks) are specified to function as a system. The compatibility of the cable to be installed with the proposed termination components shall be recognized and documented by the termination component manufacturer.

K. Manufacturers:

1. Panduit PUP6C04BU-U
2. Panduit PUP6AV04BU-UG

2.05 Information Outlet

A. General

1. Station cables shall each be terminated at their designated workstation location in the connector types described in the subsections below. Included are modular jacks, faceplates, and surface mount raceway. The combined assembly is referred to as the Standard Information Outlet (SIO). These connector assemblies shall snap into a mounting frame.
2. SIOs shall be mounted in new outlet boxes, where existing boxes are in place, on surface mount raceway typically in surface raceway with barrier, in floor mount interface boxes, or on power poles either currently owned or new.

3. The telecommunications outlet frame shall accommodate or incorporate the following:
   a. A minimum of four (4) modular jacks, when installed on a wall-mounted assembly.
   b. A mechanism for adjusting the surface plate to a plumb position.

4. When multiple jacks are identified in close proximity on the Drawings. The Contractor shall determine the optimum compliant configuration based on the products proposed.

5. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each SIO type for review by the Consultant.

B. Modular Jack

1. Data jacks shall be non-keyed 8-pin modular jacks.

2. Termination components shall be designed to maintain the cable’s pair twists as closely as possible to the point of mechanical termination.

3. Jacks shall utilize a four-layer printed circuit board to control NEXT.


5. Modular jack contacts shall accept 2500 plug insertions.

6. Modular jack contacts shall be formed flat for increased surface contact with mated plugs. These contacts shall be arranged on the PC board in two staggered arrays of four to maximize contact spacing and minimize crosstalk.

7. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.

8. Contact Plating shall be a minimum of 50 micro inches of gold in the contact area over 50 micro-inch of nickel, compliant with FCC part 68.5.

9. Jack termination shall be 110 IDC, integral to the jack housing, laid out in two arrays of four contacts.

10. Jacks shall utilize a paired punch down sequence. Cable pairs shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.

11. Jacks shall utilize tin lead plated (60% tin/40%lead) phosphor bronze 110 insulation displacement contacts.

12. Jacks shall terminate 22-26 AWG stranded or solid conductors.

13. Jacks shall terminate insulated conductors with outside diameters up to .050”.

14. Jacks shall be compatible with single conductor 110 impact termination tools.

15. Jacks shall be compatible with EIA/TIA 606 color code labeling and accept snap on icons for identification or designation of applications.

16. The Contractor shall confirm the jack colors with the Owner prior to ordering.
17. Jacks shall be marked as either T568A or T568B wiring.

18. Modular jacks shall be manufactured by:
   a. Panduit

C. Outlet Faceplates

1. Faceplates shall match the electrical outlets for material type and color.

2. Faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

3. Any unused jack positions shall be fitted with a removable blank inserted into the opening.

4. Modular jacks shall have capability to incorporate a dust cover that fits over and/or into the jack opening. The dust cover shall be designed to remain with the jack assembly when the jack is in use. No damage to the jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the jack pinning shall not be accepted.

5. Wall-mounted “voice only” outlets shall be installed where identified on the floor plan Drawings to accommodate wall-mounted telephone sets. The wall plate shall be of stainless steel construction, accommodate one RJ-45 jack, mount on a standard single gang outlet box or bracket, and include mating lugs for wall phone mounting.

6. All standard information outlets and the associated jacks shall be of the same manufacturer throughout each/the building. An allowable exception, however, is the wall-mounted “voice only” outlet described above.

7. Faceplates shall be manufactured by modular jack manufacturer.

D. Surface Mount Interface Box

1. Low profile, surface mount boxes shall incorporate recessed designation strips at the top for identifying labels. Designation strips shall be fitted with clear plastic covers.

2. The box shall feature built-in cable management for both fiber and copper applications.

3. Any unused jack positions shall be fitted with a removable blank inserted into the opening.

4. Modular jacks shall have capability to incorporate spring-loaded shutter door for added protection from dust and other airborne contaminants. The dust cover shall be designed to remain with the jack assembly when the jack is in use.

5. The box shall have the capability to incorporate optional magnets that can be internally mounted.

6. Surface mount box shall be manufactured by modular jack manufacturer.

2.06 Additional Modules for Copper Cabling

A. Additional modules for copper shall include the following:

1. 50 and 75 Ohm BNC coax coupler modules, male-male

2. F-type coax coupler module, male-male threaded
3. RCA connector modules with black, red, yellow, and white inserts
4. Solder, pass-through and punch-down termination types
5. Video connector modules - coupler and punch-down termination types
6. Blank module to reserve space for future additions

B. The connectors shall be designed to allow snap-in installation into the outlet faceplates.

Part 3 - Execution

3.01 Testing

A. Refer to Section 27 00 00 for additional requirements.

3.02 Twisted Pair Test Equipment

A. Test equipment used under this contract shall be from a manufacturer who has a minimum of five years' experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.

B. All test tools of a given type shall be from the same manufacturer and have compatible electronic results output. Test adapter cable shall be approved by the manufacturer of the test equipment. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.

C. Test equipment shall:
   1. Be capable of certifying Category 5E, 6 and 6A permanent links.
   2. Have a dynamic range of at least 100dB to minimized measurement uncertainty.
   3. Be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
   4. Include S-band time domain diagnostics for NEXT and return loss.
   5. Be capable of running individual NEXT, return loss, etc., measurements in addition to AutoText.
   6. Include a library of cable types, stored by major manufacturer.
   7. Store at least 1000 Category 5e, 6 or 6A autotests in internal memory.

D. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurements.

E. The approved manufacturer of the test equipment is Fluke and JDSU/Viavi.

3.03 Training

A. Refer to Section 27 00 00 for additional requirements.

3.04 Warranty

A. Refer to Section 27 00 00 for additional requirements.
3.05  Station Cabling

A. Information outlet cables with copper media (voice & data UTP and “TV” coax) shall be located as detailed on the Project Drawings.

B. The Contractor shall utilize these documents in determining materials quantities and routing.

C. Station cables shall be run to the information outlet from the telecommunications room serving each area in conduit, free-air above drop ceiling, in cable tray, and/or in modular furniture.

D. The maximum station cable drop length for UTP cables shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and shall include any slack required for the installation and termination. The Contractor shall install station cabling in a fashion to avoid unnecessarily long runs.

E. Contractor shall verify cable lengths comply with published standards; prior to installation of any horizontal cabling, this Contractor shall verify cable paths and confirm no horizontal cable will exceed 295 total feet. If it is determined that the cable will exceed 295’, this Contractor shall route the cabling to another telecommunications room or determine shorter path so cables are under 295’. If this is not possible, the Contractor shall notify the Consultant prior to installation. Failure to do this step will not result in a change order from the Contractor.

F. All cables shall be installed splice-free unless otherwise specified.

G. During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.

H. Avoid abrasion and other damage to cables during installation.

I. All cable shall be free of tension at both ends. In cases where the cable shall bear some stress, Kellom grips may be used to spread the strain over a longer length of cable.

J. Where installed free-air, installation shall consider the following:

1. Cables shall run at right angles and be kept clear of other trades’ work.

2. Cables shall be supported according to code, using “J-hooks” anchored to ceiling concrete, walls, piping supports, or structural steel beams.

3. Hooks shall be designed to maintain cable bend to larger than the minimum bend radius (typically 4x the cable diameter).

4. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If cable “sag” at mid-span exceeds 6 inches, another support shall be used.

K. Cable shall never be laid directly on the ceiling grid.

L. Cables shall not be attached to existing cabling, plumbing, or steam piping, ductwork, ceiling supports, or electrical or communications conduit.

M. Manufacturers’ minimum bend radius specifications shall be observed in all instances. Use of plastic cable ties is not acceptable. Cable bundles shall be neatly dressed with use of Velcro type straps.
N. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.

O. A coil of three (3) feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook directly above conduit stub up from work area outlets) before the cables enter a fishable wall, conduit, surface raceway, or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15 feet of slack shall be left in each station cable under 250 feet in length to allow for change in the office layout without re-cabling. These “service loops” shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

P. To reduce or eliminate EMI, the following minimum separation distances from ≤480V power lines shall be adhered to:

1. Twelve (12) inches from power lines of ≤5-kVA
2. Eighteen (18) inches from high voltage lighting (including fluorescent)
3. Thirty-nine (39) inches from power lines of 5-kVA or greater
4. Thirty-nine (39) inches from transformers and motors

Q. All openings shall be sleeved and firestopped per prevailing code requirements upon completion of cable installation.

3.06 Information Outlet

A. Information outlets shall be flush mounted on wall-mounted boxes, in floor-mounted boxes, on surface raceway, or on modular furniture.

B. Any outlets to be added where these conditions are not met shall be positioned at a height matching that of existing services or as directed otherwise by the Site Coordinator and the Consultant. Nominal height (from finished floor to center line of outlet) in new installation shall be as follows:

1. Standard Voice & Data Outlet (SIO) shall match adjacent electrical outlets.
2. Wall-Mounted Telephone Outlet (Standard Voice only) shall meet ADA requirements for both front and side reach access.

C. The Contractor shall coordinate the style of the telecommunication outlets to be installed in the floor mount boxes and surface mount raceways with the Owner.

3.07 Cable Termination

A. At the telecommunication closet, all data and voice cables shall be positioned on termination hardware in sequence of the outlet ID, starting with the lowest number.

B. Termination hardware (blocks and patch panels) positioning and layout will be reviewed and approved by the Consultant prior to construction. The review does not exempt the Contractor from meeting any of the requirements stated in this document.

C. Cable Termination – Data/Voice UTP

1. Data/voice patch panels shall be designed and installed in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections.
2. Data patch panels shall be sized to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.

3. At information outlets and data/voice patch panels, the installer shall ensure that the twists in each cable pair are preserved to within 0.5 inch of the termination for data/voice cables. The cable jacket shall be removed only to the extent required to make the termination.

D. Cable Termination – Fiber Optic

1. All fibers shall be terminated using the specified connector type.

2. All terminated fibers at the telecommunications closets shall be mated to couplings mounted on patch panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.

3. All couplings shall be fitted with a dust cap.

4. Fibers from multiple locations may share a common enclosure, but they shall be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure, provided they are clearly identified as such. Fibers from different locations shall not share a common connector panel (e.g., “insert”).

5. Slack in each fiber shall be provided as to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30” high workbench positioned adjacent to the termination enclosure(s). A minimum of one meter (~39”) of slack shall be retained regardless of panel position relative to the potential work area.

6. If the cable is armored the Contractor shall install a plastic twist-on bushing on each end of interlocking armored fiber to protect cable from sharp edges of the armor.

3.08 Test Data – Copper Media

A. The test result records saved by the tester shall be transferred into a Windows-based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee shall be made that these results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test. Comma separated value (CSV) format is not acceptable.

B. The database for the completed job – including twisted-pair copper cabling links, if applicable – shall be stored and delivered on CD-ROM. This CD-ROM shall include the software tools required to view, inspect, and print any selection of test reports.

C. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:

1. The identification of the link in accordance with the naming convention defined in the overall system documentation.

2. The overall Pass/Fail evaluation of the copper channel-under-test, including the NEXT worst-case margin (margin is defined as the difference between the measured value and the test limit value).
3. The overall Pass/Fail evaluation of the fiber link-under-test, including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).

4. The date and time the test results were saved in the memory of the tester.

3.09 Copper Station Cables

A. Station cabling testing shall be from the jack at the outlet in the work area to the patch panel on which the cables are terminated.

B. Testing shall be of the permanent link. Contractor shall warrant performance, however, based on channel performance and provide patch cords that meet channel performance criteria. All cabling not tested strictly in accordance with these procedures shall be retested at no cost to the Owner.

C. Testing shall be from the jack at the SIO to the patch panel on which the cables are terminated at the wiring hub.

D. Horizontal “station” cables shall be free of shorts within the pairs and shall be verified for continuity, pair validity and polarity, and wire map (conductor position on the modular jack). Any defective, split, or mispositioned pairs shall be identified and corrected.

E. Testing of the cabling systems rated at TIA Category 5e/6/6a and above shall be performed to confirm proper functioning and performance.

F. Testing of the transmission performance of station cables (Category 5e/6/6a) shall include the following:
   1. Length
   2. Attenuation
   3. Pair to Pair NEXT
   4. ACR
   5. PSNEXT Loss
   6. Return Loss
   7. Pair to Pair ELFEXT Loss or ACRF
   8. PSEFEXT Loss or PS-ACRF
   9. Propagation Delay
   10. Delay Skew
   11. Return Loss

G. The maximum length of station cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables.

H. Worst case performance at 20°C, based on a horizontal cable length of 90 meters and equipment cord length of 4 meters, shall be as follows:
   1. CATEGORY 6 (Permanent LINK)
<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Insertion Loss (Maximum dB)</th>
<th>NEXT Loss Pair to Pair (dB)</th>
<th>PS-NEXT Loss (dB; Worst Case)</th>
<th>ELFEXT Loss Pair to Pair (dB)</th>
<th>PS-ACRF Loss (dB)</th>
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2. CATEGORY 6a (Permanent LINK)

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<tr>
<th>Frequency (MHz)</th>
<th>Insertion Loss (Maximum dB)</th>
<th>NEXT Loss Pair to Pair (dB)</th>
<th>PS-NEXT Loss (dB; Worst Case)</th>
<th>ACRF Pair to Pair (dB)</th>
<th>PS-ACRF (dB)</th>
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<td>26.7</td>
<td>23.8</td>
<td>10.2</td>
<td>7.2</td>
</tr>
</tbody>
</table>

I. In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation method. The Contractor shall make additional tests as the Consultant deems necessary at no additional expense to the Owner or Consultant.

J. All data shall indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combination and in both directions when required by the appropriate standards.

K. Cables shall be tested to the maximum frequency defined by the standards covering that performance category. Transmission Performance Testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify “PASS” on each cable and display the specified parameters—comparing test values with standards-based “templates” integral to the unit.
SECTION 27 16 00  
COMMUNICATIONS CONNECTING CORDS

Part 1 - General

1.01 Scope

A. This section describes the products relating to high quality Category 6 voice and data patch cords.

B. In this section the term patch cords refers to the cords that connect Owner provided data network electronics to the horizontal cable infrastructure.

C. It is important that the horizontal cable system and the provided patch cords work as one complete system for guaranteed channel performance. Patch cords shall be manufactured by the same manufacturer as the jack and patch panels.

D. The Contractor shall provide and deliver all cords as listed in this section. The Owner will be responsible for installation of cords.

1.02 Related Work

A. Section 27 00 00 – General Technology Requirements

B. Section 27 05 00 – Communications General Requirements

C. Section 27 05 23 – Pathways for Technology Systems

D. Section 27 05 26 – Grounding and Bonding for Technology Systems

E. Section 27 11 00 – Communications Equipment Rooms

F. Section 27 13 00 – Communications Backbone Cabling

G. Section 27 15 00 – Communications Horizontal Cabling

H. Section 27 18 00 – Communications Labeling and Identification

I. Section 27 40 00 – AV/Multimedia General Requirements

J. Section 27 41 00 – Audio Visual Systems

K. Section 27 51 00 – Distributed Communications Systems

L. Section 27 60 00 – Physical Security General Requirements

M. Section 27 62 00 – Electronic Access Control System

N. Section 27 64 00 – Video Surveillance System

O. Section 27 66 00 – Intrusion Detection System

1.03 Definitions

A. Refer to Section 27 00 00 for additional definitions.
1.04 Reference Standards and Codes
   A. Refer to Section 27 00 00 for additional requirements.

1.05 Qualifications
   A. Refer to Section 27 00 00 for additional requirements.

1.06 Pre-Construction Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.07 Construction Progress Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.08 Closeout Submittals
   A. Refer to Section 27 00 00 for additional requirements.

Part 2 - Products

2.01 Substitutions
   A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Category 6 & 6A Patch Cords
   A. The Owner has the right to determine the final length of the patch cords after the contract is awarded.

   B. All patch cords shall be round and consist of eight insulated, stranded copper conductors, arranged in four color-coded twisted pairs within a flame retardant jacket and be backwards compatible with lower performing categories. Modular patch cords shall utilize ISO termination method that is designed to reduce and control near-end cross talk (NEXT) and far end cross talk (FEXT) without compromising signal impedance.

   C. Both ends of the cord shall be equipped with modular 8-position (RJ45 style) plugs wired straight through with standards compliant wiring. All modular plugs shall exceed FCC CFR 47 part 68 subpart F and IEC 603.7 specifications, and have 50 micro inches of gold plating over nickel contacts. Cable shall be label-verifiable. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Patch cords shall have color-coded insert molded strain relief boot with a latch guard to protect against snagging. Additional color-coding shall be available by the use of snap-in icons.

   D. Patch cords shall be wired straight through. Pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring per ANSI/TIA/EIA-568-B. Patch cords shall be unkeyed.

   E. The manufacturer of the cords shall be the same as the manufacturer for UTP termination hardware (jacks & patch panels). Cords shall be highest quality patch cords available by connectivity manufacturer.

   F. This Contractor shall provide patch cords as follows:
1. Contractor shall confirm patch cord and jack colors with Owner and Consultant.

2. The patch cord category shall match the horizontal channel. I.e. where Cat 6 horizontal cable is installed, provide Cat 6 patch cords.

3. Patch cords shall be provided for two-thirds of all terminated points in the building. 50 percent shall be 10’, 25 percent shall be 7’, and 25 percent shall be 5’. Final measurements and quantities to be confirmed with Owner.

4. All patch cords shall be pre-manufactured and approved by Owner

5. Approved Manufacturer:
   a. Cat 6
      i. Panduit UTPSP*xx (*=length in ft. & xx = color code)
      ii. Panduit UTP28SP*xx (*=length in ft. & xx = color code)
   b. Cat 6A
      i. Panduit UTP6A*xx (*=length in ft. & xx = color code)
      ii. Panduit UTP28X*xx (*=length in ft. & xx = color code)

2.03 Fiber Optic Patch Cords

A. The Owner has the right to determine the final length of the patch cords after the contract is awarded.

B. All MM fiber optic patch cords shall:
   1. Be duplex 2-3mm tight buffer design with Aqua jacket.
   2. Have LC-LC connectors with straight thru connectors (A-A Polarity).
   3. Have 50-micron OM4 core.

C. All SM fiber optic patch cords shall:
   1. Be duplex 2-3mm tight buffer design with Yellow jacket.
   2. Have LC-LC connectors with straight thru connectors (A-A Polarity).
   3. Have 8.3-micron OS2 core.

Part 3 - Execution

3.01 Testing
A. Refer to Section 27 00 00 for additional requirements.

3.02 Training
A. Refer to Section 27 00 00 for additional requirements.

3.03 Warranty
A. Refer to Section 27 00 00 for additional requirements.
3.04 Ordering and Delivery

A. Prior to ordering patch cords the Contractor shall schedule meeting with Owner and Consultant to verify patch cord lengths, colors and quantities.

B. Contractor shall coordinate delivery of patch cords with Owner. Contractor shall have list of delivered cords and shall have Owner sign delivery sheet at time of delivery.

End of Section
SECTION 27 18 00  COMMUNICATIONS LABELING AND IDENTIFICATION

Part 1 - General

1.01 Scope

A. This section describes the products and execution requirements relating to labeling of telecommunications cabling, termination components, and related subsystems. Covered systems include the following:

1. Equipment room backboards and equipment racks
2. Station cable and terminating equipment
3. Telecommunications grounds and related components

1.02 Related Work

A. Section 27 00 00 – General Technology Requirements
B. Section 27 05 00 – Communications General Requirements
C. Section 27 05 23 – Pathways for Technology Systems
D. Section 27 05 26 – Grounding and Bonding for Technology Systems
E. Section 27 11 00 – Communications Equipment Rooms
F. Section 27 13 00 – Communications Backbone Cabling
G. Section 27 15 00 – Communications Horizontal Cabling
H. Section 27 16 00 – Communications Connecting Cords
I. Section 27 40 00 – AV/Multimedia General Requirements
J. Section 27 41 00 – Audio Visual Systems
K. Section 27 51 00 – Distributed Communications Systems
L. Section 27 60 00 – Physical Security General Requirements
M. Section 27 62 00 – Electronic Access Control System
N. Section 27 64 00 – Video Surveillance System
O. Section 27 66 00 – Intrusion Detection System

1.03 Definitions

A. Refer to Section 27 00 00 for additional definitions.

1.04 Reference Standards and Codes

A. Refer to Section 27 00 00 for additional requirements.
1.05 Qualifications
   A. Refer to Section 27 00 00 for additional requirements.

1.06 Pre-Construction Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.07 Construction Progress Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.08 Closeout Submittals
   A. Refer to Section 27 00 00 for additional requirements.

Part 2 - Products

2.01 Substitutions
   A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Labels
   A. All labels shall be permanent and be machine generated (e.g., Brady or Panduit). No handwritten or non-permanent labels shall be allowed. Labels shall be Brady “I.D. Pro” or XC-Plus or equivalent. Labeling on backboards and/or equipment racks may be pre-cut adhesive type.

   B. Characters on all labels shall be black printed on a white background.

   C. Label size shall be appropriate to the cable size(s), outlet faceplate layout, patch panel design, or other related equipment sizes and layouts.

   D. All labels to be used on cables shall be self-laminating, white/transparent vinyl, and be wrapped around the cable sheath. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminated over the full extent of the printed area of the label.

   E. Labels used to identify innerduct carrying fiber optic cable shall be labeled with a durable yellow polyethylene tag that reads “CAUTION Fiber Optic Cable” and includes blank spaces for adding (1) fiber count and (2) destination information. An example of a compliant product is VIP Products’ “Caution Write-On Coverall Tag.”

Part 3 - Execution

3.01 Testing
   A. Refer to Section 27 00 00 for additional requirements.

3.02 Training
   A. Refer to Section 27 00 00 for additional requirements.
3.03 Warranty
   A. Refer to Section 27 00 00 for additional requirements.

3.04 General
   A. The Contractor shall match the Owner’s standard labeling scheme.
   B. Clean surfaces before attaching labels.
   C. Install all labels firmly. Labels attached to terminating equipment such as backboards, faceplates, 110 blocks, and patch panels shall be installed plumb and neatly on all equipment.

3.05 Labeling of Cabling and Termination Components
   A. Backboard and Equipment Racks
      1. Backboards and equipment racks shall be labeled by the Contractor identifying the telecommunication room. Additionally, equipment racks shall have an alpha character after the room number unique to that particular communications closet. For example, TR1-A would be the first rack in TR1.
      2. Character height shall be 1-inch (minimum).
   B. Cabling
      1. Horizontal cables shall have a machine generated wrap around cable label within 4” of each end of the cable. Label shall be clearly legible and meet TIA-EIA 606 standards. Character height shall be .25” (minimum).
      2. Voice/data/video backbone cables shall have a machine generated wrap around cable label within 12” of each end of the cable. Label shall be clearly legible and meet TIA-EIA 606 standard. Character height shall be .5” (minimum).

3.06 Fiber Optic Backbone, Riser Cables, and Termination Components
   A. All fiber optic backbone and copper (inter-building, riser, and tie) cables shall be identified AT BOTH ENDS with a designation that identifies where the opposite end of the same cable terminates (e.g., equipment room or telecommunications room I.D.). In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.
   B. Each fiber optic termination panel shall be clearly labeled indicating the destination of the cable(s) and the fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

3.07 Standard Information Outlet (SIO) Faceplates
   A. All faceplates shall be clearly labeled indicating the destination of the cable(s) (telecommunication room number), the data patch panel(s) letter designation, the data port number(s) on the data patch panel(s), and the voice cable number(s).
   B. Telecommunications outlets are to be labeled (1) on the cover of the assembly and (2) on each cable terminated at that location.
   C. Station cables shall be labeled within two inches of the cable end.
3.08 Data Patch Panels

A. All data patch panels shall be clearly labeled indicating the telecommunication room number, the data patch panel letter designation, and the data port number on the data patch panel (ports 1 through 48). Each telecommunication room shall start with data patch panel ‘A’ and continue through the alphabet.

B. A data port schedule for each telecommunication room shall be created in spreadsheet format (Excel) with the telecommunication room number, data patch panel letter designations, data port numbers, and room numbers identified in the spreadsheet. In addition, for each data patch panel port, a field shall be provided in the spreadsheet for the Owner to manage the cabling infrastructure by recording the device and any special notes pertaining to the room utilizing the data cable terminated to the port.

C. Refer to Telecommunication “T” Series Project Drawings for standard information outlet faceplate and data & voice patch panel labeling scheme requirements. A sample of the data and voice port schedules is to be provided to the Owner, in the cable record book and in electronic format (Excel spreadsheet), with final documents provided on the Project Drawings.

3.09 Fiber Optic Cables and Termination Components

A. All fiber optic cables, termination enclosures and connector panels, and splice closures shall be clearly labeled.

B. In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.

C. Each fiber optic termination panel shall be clearly labeled indicating (1) the destination(s) of the cable(s) and (2) fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

3.10 Ground System Labeling

A. All grounds shall be labeled as close as practical to the point of termination (for ease of access to read the label). Labels shall be nonmetallic and include the following statement: “WARNING: If this connector or cable is loose or must be removed, please call the building telecommunications manager.” Refer to ANSI/TIA/EIA 606 for additional labeling requirements.

End of Section
SECTION 27 40 00

AV/MULTIMEDIA GENERAL REQUIREMENTS

Part 1 - General

1.01 Scope

A. Refer to Section 27 00 00 for additional project scope information.
B. Successful bidder shall provide, install, configure, and provide warranty service for audiovisual systems, including displays, audio/video/graphics switching and distribution systems, integrated control systems, and other equipment as described herein.

1.02 Related Work

A. Section 27 00 00 – General Technology Requirements
B. Section 27 05 00 – Communications General Requirements
C. Section 27 05 23 – Pathways for Technology Systems
D. Section 27 05 26 – Grounding and Bonding for Technology Systems
E. Section 27 15 00 – Communications Horizontal Cabling
F. Section 27 16 00 – Communications Connecting Cords
G. Section 27 18 00 – Communications Labeling and Identification
H. Section 27 41 00 – Audio Visual Systems
I. Section 27 41 60 – Audio DSP Configuration
J. Section 27 41 70 – Integrated Control Systems

1.03 Definitions

A. Refer to Section 27 00 00 for additional definitions.

1.04 Reference Standards and Codes

A. Refer to Section 27 00 00 for additional requirements.

080320
   InfoComm International.
   [www.infocomm.org/cps/rde/xchg/infocomm/hs.xsl/35324.htm](http://www.infocomm.org/cps/rde/xchg/infocomm/hs.xsl/35324.htm)

F. Copyright Act of 1976
   U.S. Copyright Office
   101 Independence Ave. S.E.
   Washington, DC 20559
   Phone: (202) 707-3000

### 1.05 Qualifications

A. Refer to Section 27 00 00 for additional requirements.

B. Primary AV Contractor shall have at least one (1) employee assigned to the project in a design or management role, and at least one (1) employee assigned to the project in an installing technician role, holding at least one of the follow certifications:

1. CTS (InfoComm International)
2. CTS-I (InfoComm International)
3. CTS-D (InfoComm International)
4. EST-L2 (National Systems Contractor Association)

C. Refer to subsequent sections for section specific qualification requirements.

### 1.06 Pre-Construction Submittals

A. Refer to Section 27 00 00 for additional requirements.

B. Structurally Mounted Elements: Including but not limited to monitors, projectors, projection screens, and loudspeakers.

C. Frequency Assignment Plans: Provide for all wireless microphones.

D. Custom Engraving: Layout and labeling/engraving of custom products including wall plates and interconnection panels. Provide engraving detail with material and finish detail.

E. Power Distribution: Plan for distribution and switching of AC and DC power to all audiovisual devices, including sequencing order of outlets and banks. Time delay to be field configured as necessary for proper system power up and down.

### 1.07 Construction Progress Submittals

A. Refer to Section 27 00 00 for additional requirements.

### 1.08 Closeout Submittals

A. Refer to Section 27 00 00 for additional requirements.

B. Quick-Reference Guides: Contractor shall create a concise quick-reference guide covering normal system operation and basic troubleshooting procedures for each room/system type.
Length of each quick-reference guide shall be commensurate with the information needed for successful operation, subject to Owner approval.

1. Upon Owner approval, Contractor shall provide two (2) laminated copies and one (1) digital copy for each room/system type.

C. Serial Numbers: Contractor shall provide a list of serial numbers for all supplied components with serial numbers and with a unit price greater than $99. Organize list by room/system type.

1.09 Correction Period

A. Length of Period: Contractor shall offer a one year correction period to Owner for this system. Contractor shall repair all equipment and cabling problems at no additional cost to Owner during the correction period.

B. Commencement: Correction period shall begin at date of Final Acceptance.

C. Final Acceptance: shall be defined as the date at which all contract work (save for a correction period) is complete, including punch list completion & verification, closeout submittals, and written verification by the Owner is obtained by the Contractor that the systems have been accepted.

D. Response: Contractor shall respond by phone within two (2) hours to calls for service or assistance from Owner during normal business hours for the duration of the correction period.

E. On-site Response: Contractor shall respond on-site within eight (8) business hours from the time of the initial phone contact in the event that the issue cannot be resolved over the phone.

F. Equipment on Loan: Contractor shall loan equipment for any broken, defective, or non-functional equipment that cannot be repaired and returned within one week. Contractor shall provide shipping, delivery, and integration at no additional cost to Owner. Equipment shall be comparable in size, speed, brightness, and relevant performance specifications, as determined by Owner.

G. Projection Lamps: Projection lamps are to be warranted by Contractor for a minimum of 90 days, or the rated life expectancy of the lamp, whichever comes first.

H. Damaged Equipment: Equipment that is damaged due to intentional misuse, abuse or negligence is not covered under this warranty; however, Contractor shall assist Owner in putting the system back in working order in the shortest possible timeframe while charging normal service rates for labor and equipment.

1.10 Ownership

A. Property Rights: Contractor assigns to Owner any and all intellectual property rights and applications made by Contractor, or its agents or employees in connection with the performance of this contract. Contractor also acknowledges and agrees that services rendered in connection with the performance of this contract shall be a "work made for hire" within the meaning of Section 201 inventions of the Copyright Law of 1976.
Part 2 - Products

2.01 Substitutions

A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Product Specifications

A. Provisions: Product specifications are provided in subsequent sections to Contractor for the appropriate configuration and/or provision of accessories as well as for a guide to indicate key features for possible substitutions.

B. Where wireless microphone systems are specified, Contractor shall determine optimal frequency range for final product selection and submit Manufacturer’s recommended frequency band for Owner and Consultant approval prior to ordering equipment. Contractor shall provide congruent frequency band products where like systems are specified for interoperability of components. Where three (3) or more wireless microphones are specified within the same system, Contractor shall provide and install necessary antennae distribution for optimal performance, to be submitted for Owner and Consultant approval during pre-construction phase.

2.03 Miscellaneous Material

A. Required Equipment: Contractor shall provide additional system components typically and reasonably required to make system operational even though not specifically indicated in Drawings, Appendices or Specifications including, but not limited to, cable, connectors, connecting accessories, adaptors, power supplies, power strips, rack mounting adapters and shelves, cover plates and closure panels, relays and switches, remote antenna mounts, terminal blocks, and related connector and termination hardware required by but not supplied with the equipment.

B. Blank Fill Panels: Contractor shall provide blank fill panels to cover any openings in equipment racks provided under this contract whether specified in the equipment schedules or not. Fill panels shall match finish of specified rack hardware.

C. Power Distribution Strips: Contractor shall provide power distribution strips as necessary for distributing power within equipment racks and consoles. Strips shall be UL listed, be securely mountable, and appropriate for professional installation.

D. Wall Openings: Contractor shall provide blank faceplates to cover any unused openings within the project area. Faceplate type and finish to match electrical outlets in the project.

2.04 Power Devices

A. Refer to Section 27 00 00 for additional requirements.

B. All audio amplifiers shall be on sequenced outlets.

2.05 Cable

A. Cable shall be provided and installed as detailed herein. Cable installed that does not conform to these standards or that has not been given prior approval by Consultant shall be removed by Contractor and replaced at Contractor’s sole expense.
B. Plenum: Plenum-rated cables shall be used where required by code or by best practices. All cables run beneath raised floor shall be plenum-rated.

C. Installed Video: Video signal coaxial cables shall have #18 solid copper center conductor, gas-injected high density Polyethylene or Fluorinated Ethylene Propylene insulation, copper braid shield of at least 95% coverage and 100% dual-sided foil and black PVC jacket unless color is otherwise noted. Cable shall be designed as a low loss serial digital video cable. Belden 1694A, WestPenn 6350, Canare L-5CFB, Liberty 18-CMR-SD, or equal. Plenum cable, Belden 1695A, WestPenn 256350, Liberty 18-CMP-VID-COAX, or equal.

D. Flexible Video: Short video cables that are intended to be moved or adjusted on a regular, frequent basis may be constructed of a stranded bare copper center conductor RG-59/equivalent cable with >94% copper braid shield and polyethylene dielectric. Canare LV-61S, Belden 1505A, WestPenn 819, or equal. Plenum cable, Belden 1506A, WestPenn 25819, or equal.

E. High Resolution RGBHV Graphics/Video: Cable type and size shall be selected to provide a minimum of 250 MHz bandwidth (-3dB) at over the length of each RGBHV signal path from source to display, including losses and gains through cable loss, signal processing, switching and distribution equipment. Manufacturer shall designate cable as suitable for high-resolution use. Extron MHR-5, Liberty RGB5C-25-CM or equal. Plenum cable, Extron MHR-5P, Liberty RGB5C-25-CMP, or equal.

F. Installed Line Level and Microphone (single line): Audio signal cable shall have twisted pair #22 stranded tinned copper conductors, polyethylene conductor insulation, aluminum-polyester foil shield, #24 stranded tinned copper drain wire and black PVC jacket. Belden 8761, West Penn 291, Canare L-2T2S, Liberty 24-2P-STAR, or equal. Plenum cable, Belden 88761 or equal.

G. Portable Microphone, Enclosure and Breakout Line Level Audio: Cable shall have 4 conductors per channel arranged in star quad double-balanced pairing, #24 stranded conductors of at least 40 tinned annealed copper wires, 100% coverage wrap shield, tinned copper braid shield of approximately 50% coverage, uniformly round form and black PVC jacket. Canare L-4E6S, Belden 8723, WestPenn 355, or equal. Plenum Cable, Belden 88723, Liberty 24-4P-PLCSH-WHT, or equal.


I. Wireless Microphone Antenna Extension Cable: 50-Ohm coaxial cable, or as directed by microphone manufacturer.

J. Loudspeaker Wire: 14 AWG minimum.

K. UTP Cable: Shall be consistent with Project standards for CAT-6 cable, unless otherwise noted in specification or recommended by hardware manufacturer for use with their equipment.

L. Control: Shall be as recommended by equipment manufacturer, with the appropriate number of conductors for the application.

M. Cable Construction: Contractor shall fabricate interconnecting cables using products defined in this section unless equipment manufacturer-provided cable is of a specialized or proprietary nature. Pre-manufactured cables are subject to prior approval by Consultant.
N. Labels: Labels shall include a white paper or vinyl slip with typed or machine printed
designations, secured in place with a wider section of clear heat shrink tubing or integral clear
adhesive-backed plastic.

O. Terminations: Provide specialized terminating hardware as required.

P. Schedule: Contractor shall submit schedule prior to installation for Consultant review
indicating cable types that will be used on the project.

2.06 Connectors

A. Connectors shall be provided and installed as detailed herein. Connectors installed that do
not conform to these standards or that have not been given prior approval by Consultant shall
be removed by Contractor and replaced at Contractor’s sole expense.

B. HDMI (Video/Audio/Control): Cables to be factory-terminated with molded strain relief.

C. BNC (Video): Video signal BNC connectors shall be 3-piece crimp-on type with insertion
barrel and ferrule, and gold flashed crimp-on center pin. Barrel shall provide full
circumferential contact with the braid. Fittings shall be sized to fit the cable. Canare BCP-C
series or equal. Crimping and die tools shall be Canare TC-1 Hand Crimp Tool with
appropriate TCD die sets or equal.

D. RCA (Video): Video signal RCA connectors shall be 3-piece crimp-on type with gold flashed
center pin, Canare RCAP-C series or equal. Crimping and die tools shall be Canare TC-1
Hand Crimp Tool with appropriate TCD die sets or equal.

E. F (Video): Video signal F connectors shall be 3-piece crimp-on type with gold flashed crimp-
on center pin. Canare FP-C series or equal. Crimping and die tools shall be Canare TC-1
Hand Crimp Tool with appropriate TCD die sets or equal.

F. BNC (RGBHV Graphics): Graphics signal BNC connector shall be crimp-on type with
insertion barrel and ferrule, and gold flashed crimp-on center pin. Barrel shall provide full
circumferential contact with the braid. Fittings shall be sized to fit the cable. BNC
manufacturer, model and tools as recommended by the manufacturer of the RGBHV/graphics
cable.

G. XLR: Strain relief shall be sized to fit the cable. Connector shell shall be isolated from all
contacts. Neutrik CA-NC series or equal.

H. Mini-XLR: Strain relief shall be sized to fit the cable. Connector shell shall be isolated from all
contacts. Switchcraft or equivalent.

I. Phono (RCA): Phono/RCA connectors shall have gold contact and solid center pin with metal
strain relief. Canare F-10 or Canare F-09 or equal.

J. Phone (1/4 inch): Reinforced one-piece body shall have brass bar running length of handle.
Canare F-15 (TS) or Canare F-16 (TRS) or equal.

K. Mini (1/8 inch): Shall be Canare F-11 (TS) or Canare F-12 (TRS) or equal.

L. RJ45: RJ45 jacks that are field-terminated shall be punch-down type. All flexible connectivity
to AV devices shall be factory-molded patch cables. Where a field-terminated plug is required
by manufacturer recommendations, Contractor shall use appropriate connector type to the
type of cable used (solid vs. stranded).
M. Shielded cable to be terminated with shielded connectors or as required by manufacturer recommendations.

N. DM, DM8G+: Shall be Crestron shielded RJ-45 and fiber connectors, as recommended by manufacturer of DM or DM8G+ system.

O. DX, DX-LINK: Shall be AMX shielded RJ-45 and fiber connectors, as recommended by manufacturer of DX or DX-LINK system.

P. Schedule: Contractor shall submit schedule prior to installation for Consultant review indicating connectors that will be used on the project.

2.07 Interface Panels

A. Finish: Interface plates and connector panels shall be as indicated on Drawings and as specified herein. Finish on custom wall interface plates shall match that of electrical and other work and shall be coordinated with Consultant prior to ordering. Connector panels in equipment racks shall match finish of rack frame and specified/provided blank panels unless called out otherwise in equipment schedules.

B. Floor Boxes: Floor box plates shall be provided wherever connectivity through a floor box is indicated on drawings.

C. Labels: Interface plates and connector panels shall be engraved to show connector functionality. Engravings shall be finished with a contrasting color to plate finish.

D. Connector Placement: Verify connector layout detail for custom panels

E. Box Mounts: Wall and floor interface plates shall mount to appropriate electrical conduit boxes unless indicated otherwise.

F. Cut-ins: Where no box is provided, Contractor shall cut in appropriate opening for plate, and provide appropriately sized mud-ring/caddy to securely attach plate to wall.

G. Rack Blank Panels: Contractor shall provide all blank rack panels necessary to fill opening in the front of AV equipment racks, whether specified in the equipment schedules or not.

2.08 Fire Stopping Materials

A. Refer to Section 27 00 00 for additional requirements.

Part 3 - Execution

3.01 Testing

A. Refer to Section 27 00 00 for additional requirements.

3.02 Training

A. Refer to Section 27 00 00 for additional requirements.

3.03 Warranty

A. Refer to Section 27 00 00 for additional requirements.
3.04 Equipment

A. As required by Section 27 00 00.

1. Safety: Contractor shall use proper structural installation techniques and maintain a minimum 5:1 safety margin.

2. Custom Mounting Finish: Custom mounting hardware shall be painted by Contractor to match either color of wall, ceiling or equipment, at Consultant’s discretion.

3.05 Spare Parts and Remote Controls

A. Projector lamps and filters

B. Remote controls and batteries

C. Adapters

3.06 Interconnection

A. As required by Section 27 00 00.

1. Interpretation: Contractor shall make system interconnections as indicated on Drawings and specified herein. Contractor shall interpret Drawings using an understanding of the equipment and general system topology (both existing and future/specified). Contractor shall provide power and control lines to and from power supplies, remotely controlled equipment and other devices even though not explicitly indicated on Drawings or listed in equipment tables.

2. Additional: Contractor shall be responsible for associated equipment signals not specifically documented in provided drawings. These include synchronizing signals, transmitting and receiving antennas, and LAN connections to equipment provided and/or installed by Contractor.

3.07 Cable Management

A. As required by Section 27 00 00.

1. Above Ceiling: Cabling located above ceilings shall be tied off to and supported by ceiling supports or other structures at a minimum of eighteen (18) inches above the ceiling.

2. Not on Ceiling: Cabling shall not lie on the ceiling.

3. Wall Cabling: Cables installed in a horizontal fashion along wall surfaces shall be installed in surface raceway approved by Owner and Consultant.

4. Floor Cabling: Cabling placed at floor level such as microphones shall be installed on the floor in the shortest possible route to the nearest wall considering traffic patterns and in an enclosure designed for that use and offering protection from foot traffic.

5. Desk Cabling: Where a cable is installed inside desk furniture, a means of protecting the cables and holding cabling to a fixed surface shall be installed.

6. Grommets: Holes in horizontal furniture surfaces for cable pass-through shall be provided with appropriate sized grommet. Grommet shall be black unless otherwise specified or required.
7. Stub-ups: Where conduit is stubbed-up through the floor and exposed, Contractor shall wrap cables with black expandable sleeving and secure at least three (3) inches below level of conduit top.

   a. Where conduit is stubbed-up through floor and concealed within furniture, Contractor shall install tether comprised of aircraft cabling to limit the distance furniture may be moved away from stubbed-up conduit. Cabling service loop exiting stubbed-up conduit and entering furniture shall be longer than the corresponding tether, providing protection against movement of furniture that would otherwise damage installed cabling.

8. Umbilicals: Exposed cable umbilicals, such as those between instructional furniture and a floor- or wall-mounted plate, shall be covered in black expandable sleeving, with neatly finished ends (heat-shrink or Consultant-approved method).

3.08 Connector Termination

A. As required by Section 27 00 00.

   1. Video Connectors: Video connectors (BNC, RCA, and F) shall be terminated using a crimp tool or dies designed specifically for the connectors being applied.

   2. XLR Connectors: Terminate XLR type connectors wired pin 2 high, pin 3 low, and pin 1 shield.

   3. UTP: UTP cable shall be terminated with appropriate crimps tools or tools specified by manufacturer.

3.09 Grounding

A. Audiovisual equipment racks shall be grounded to the telecommunication grounding system with a minimum 6 AWG grounding cable. Refer to Section 27 00 00 for additional grounding requirements.

3.10 Testing & Inspection

A. General Information: As required by Section 27 00 00.

B. Notification: Prior to start of testing, provide a list to Consultant of test equipment make, model numbers and calibration dates that will be used.

C. Testing: Contractor shall perform complete testing on system before inspection. Selected systems may be retested during inspection at Owner’s discretion.

D. Display/Output checks: Contractor shall verify that visual and audio outputs from the system are high-quality and without noticeable distortion or feedback at normal operating levels.

E. Wiring and Labeling: Contractor shall check all inputs and outputs for correct wiring and labeling.

F. Loudspeakers: Contractor shall measure the impedance of each speaker line leaving the equipment racks. For full range devices, use a frequency of 1000 Hz. For band limited devices, use a frequency appropriate for the operating range of the transducer. When documenting results, Contractor shall include the calculated impedance based on number of units on a line and the size and distance of the run. Contractor shall correct any field readings that differ more than 20% from the calculated impedance. Contractor shall use an electronic...
polarity checker to test each reinforcement speaker. Speakers shall have the same relative polarity.

### 3.11 Computer Graphics

A. Computer graphics shall be crisp and focused with respect to color alignment. If color alignment is not registered properly, Contractor shall identify source of problem and correct. EDID and other auto-registration features shall be set within AV equipment where required for optimal system performance.

### 3.12 Training

A. General Information: As required by Section 27 00 00 and following section(s).

B. Coordination and Personnel: Training shall be coordinated with Owner’s schedule, and Contractor personnel who provide training are subject to Owner’s approval.

### 3.13 Project Closeout

A. Completion: System shall be considered complete when all of the following has occurred:

1. Testing has been completed to the satisfaction of Owner and Consultant.
2. Punch-listed items have been addressed to the satisfaction of Owner.
3. As-built drawings and system documentation has been turned over to Owner and Consultant.
4. Complete operational training has been conducted with Owner’s staff.
5. System Commissioning Process has been completed.

B. Acceptance: Contractor shall secure written Acceptance of systems in the form of authorized Owner signature on Acceptance Document. This shall constitute the Date of Acceptance.

**End of Section**
SECTION 27 41 00  

AUDIO VISUAL SYSTEMS

Part 1 - General

1.01 Scope
   A. Refer to Section 27 00 00 for additional project scope information.
   B. Provide audio visual systems as well as training and warranty services for those systems as described herein.

1.02 Related Work
   A. Section 27 00 00 – General Technology Requirements
   B. Section 27 05 00 – Communications General Requirements
   C. Section 27 05 23 – Pathways for Technology Systems
   D. Section 27 05 26 – Grounding and Bonding for Technology Systems
   E. Section 27 15 00 – Communications Horizontal Cabling
   F. Section 27 16 00 – Communications Connecting Cords
   G. Section 27 18 00 – Communications Labeling and Identification
   H. Section 27 40 00 – AV/Multimedia General Requirements
   I. Section 27 41 60 – Audio DSP Configuration
   J. Section 27 41 70 – Integrated Control Systems

1.03 Definitions
   A. Refer to Section 27 00 00 and 27 40 00 for additional definitions.

1.04 Reference Standards and Codes
   A. Refer to Section 27 00 00 and 27 40 00 for additional requirements.

1.05 Qualifications
   A. Refer to Section 27 00 00 and 27 40 00 for additional requirements.

1.06 Pre-Construction Submittals
   A. Refer to Section 27 00 00 and 27 40 00 for additional requirements.

1.07 Pre-installation Procedures
   A. Refer to section 27 00 00 for additional requirements.

1.08 Construction Progress Submittals
   A. Refer to Section 27 00 00 and 27 40 00 for additional requirements.
1.09 Closeout Submittals
   A. Refer to Section 27 00 00 and 27 40 00 for additional requirements.

1.10 Correction Period
   A. General Information: Products shall be covered by Contractor correction period as required by Sections 27 00 00 and 27 40 00.
   B. Correction Period: Contractor's obligation for correction period shall not abrogate manufacturers' warranty periods.
   C. Commencement: Correction Period begins on Date of Acceptance.

Part 2 - Products

2.01 Substitutions
   A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Plans, Schematics, Schedules
   A. This specification is intended to describe the general system types/locations and components, not every connection or room. The technology drawings more fully describe these systems and must be reviewed thoroughly in conjunction with the specification.
   B. The technology floor plans indicate AV device locations, including input plates, speakers, projectors, flat panel displays, wall controllers, AV cabinets, etc.
   C. The technology schematics (located on the “Technology Details” drawing sheets) indicate AV components in each system type and how they are connected. The components are described generally (ex: “AMPLIFIER”) with the specified model indicated below. Some device model numbers are not indicated in these written AV specifications and must be found on the technology drawing schematics located in the detail sheets. The schematics also indicate specific installation and functional requirements not shown elsewhere.
   D. The technology schedules (located on the “Technology Details” drawing sheets) indicate AV components for loudspeakers, projectors, and screens. They specify which model shall be provided at each location type by using numbered identifiers that appear on the symbols on the floorplans (ex: “P1” for projector type 1).

2.03 Flat Panel Displays – Small Group Presentation
   A. Each system shall include the following major components:
      1. Input plate with HDMI
      2. HDMI cable
      3. Wall mount for flat panel display
      4. Installed interconnection cables
      5. End-user input/turn-over cables
      6. Flat panel display
B. Passive HDMI Solution
   1. Provide input plate with HDMI pigtail and HDMI cable up to display
   2. Match style appearance and manufacturer of HDBaseT extender plates used in conference rooms (see 2.05).
   3. Approved manufacturers:
      a. Crestron
      b. Extron
      c. Or pre-approved equal

2.04 Band Hall
   A. Mixing Console
   B. Speakers
   C. Rack
   D. Audio Amplifier
   E. Media Player / Recorder
   F. Power Distribution and Control
   G. Microphones
   H. Patch Cables
   I. Refer to drawings for exact components and part numbers.

2.05 Choir Hall
   A. Mixing Console
   B. Speakers
   C. Rack
   D. Media Player/Recorder
   E. Power Distribution and Control
   F. Microphones
   G. Patch Cables
   H. Refer to drawings for exact components and part numbers.

2.06 Black Box
   A. Mixing Console
   B. Speakers
C. Rack
D. Media Player
E. Power Distribution and Control
F. Microphones
G. Patch Cables
H. Refer to drawings for exact components and part numbers.

2.07 Scene Shop
A. Refer to drawings for exact components and part numbers.

2.08 Ensemble Spaces
A. Mixing Console
B. Speakers
C. Portable Rack
D. Power Distribution and Control
E. Patch Cables
F. Refer to drawings for exact components and part numbers.

2.09 Drama/Theatre Classrooms
A. Mixing Console
B. Speakers
C. Portable Rack
D. Power Distribution and Control
E. Patch Cables
F. Refer to drawings for exact components and part numbers.

2.10 Stage Areas
A. Refer to drawings for exact components and part numbers.

2.11 Approved Manufacturers:
A. Input plates / Control systems
   1. Extron
   2. Crestron
   3. Or pre-approved equal
B. Digital signal processing
   1. Symetrix
   2. Biamp
   3. Or pre-approved equal
C. Power sequencing
   1. Furman
   2. Surge-X
   3. Middle Atlantic
   4. Or approved equal
D. Other equipment
   1. Refer to schematic detail for specific manufacturers & part numbers.
   2. No substitutions unless pre-approved.

2.12 Flat Panel Displays
A. Wall Mount for Flat Panel Display
   1. The Contractor shall provide a wall mount for supporting the flat panel display.
   2. The Contractor shall install the mount above the in-wall box such that the display will just
      barely cover the box but won’t make it impossible to access.
   3. The Contractor shall coordinate the exact mounting height with the Owner.
   4. Approved Manufacturer:
      a. Chief Thinstall Tilt Series – where ADA protruding objects is a concern (corridors and
         other walk paths)
      b. Chief Fusion Tilt Series – everywhere else
B. Flat Panel Display
   1. Flat panel displays shall be Contractor-Furnished and Contractor-Installed.
   2. Flat panel display shall be commercial grade, rated for 24/7 operation
   3. Flat panel display shall support all necessary connections, including – at a minimum –
      two HDMI video inputs and an RS-232 control input
   4. Flat panel display shall be 1080p resolution at minimum
   5. Flat panel display shall NOT be a ‘smart TV’ and shall not be able to connect to the
      building’s Wi-Fi network
   6. Approved Manufacturers:
      a. Samsung
      b. LG
c. Or pre-approved equal

2.13 HDMI Inputs/Connectivity

A. AV Contractor shall provide HDMI input plates where indicated on plans. Due to HDMI distance limitations, anywhere the cable distance exceeds 30 feet, an acceptable solution shall include some form of extension. Extension can be via active HDMI cables (ex: RedMere), UTP/XTP extenders, or fiber optic HDMI cables. At locations where the end-to-end cable distance is 30 feet or less, commercial-grade passive HDMI cables may be used. Contractor shall be responsible for providing a cable channel that is reliable and functions with all source devices the Owner may use.

B. Acceptable solution shall remain entirely concealed, with only the faceplate visible. The rest of the solution – cabling, extender boxes, boosters, etc. – shall be located in walls, above ceiling, and/or behind flat panel display. Contractor shall refer to the architectural drawings, especially the reflected ceiling plans (RCP), for additional information on possible cable routes.

C. Acceptable solution shall support 4K HDMI transmission to plan for future sources and displays.

D. Acceptable solution shall be manufactured by a Pro AV manufacturer with 5+ years in the AV industry and an existing install base in central Texas.

E. Acceptable solution shall fit inside the conduits and backboxes shown in the rough-in details on the technology drawings.

F. Wherever cables are routed above ceiling, they shall carry a CMP rating.

G. Provide with turnover cables, one for each HDMI input location. Typical cable length shall be 10 feet.

2.14 USB Inputs/Connectivity

A. AV Contractor shall provide a USB input plate at the “TWS” with extension to the ceiling enclosure. Due to USB distance limitations, acceptable solutions shall include some form of extension. Typically, this is achieved using UTP/XTP extenders.

B. Acceptable solution shall remain entirely concealed, with only the faceplate visible. The rest of the solution – cabling, extender boxes, boosters, etc. – shall be located in walls, above ceiling, and/or inside ceiling enclosure.

C. Acceptable solution shall support at a minimum USB 2.0.

D. Acceptable solution shall be manufactured by a Pro AV manufacturer with 5+ years in the AV industry and an existing install base in central Texas.

E. Acceptable solution shall fit inside the conduits and backboxes shown in the rough-in details on the technology drawings.

F. Wherever cables are routed above ceiling, they shall carry a CMP rating.

G. Provide with turnover cables, one for each USB wall plate and one for each USB ceiling enclosure endpoint.
2.15 Faceplates

A. The Contractor shall provide faceplates and inserts as shown on the technology detail sheets.

B. Refer to rough-in details for backbox sizes.

C. Coordinate faceplate and insert colors to match electrical. Confirm with Architect prior to purchasing.

2.16 Integrated Control System

A. IP Interface: Contractor shall configure/modify IP-based monitoring software to allow Owner to monitor all rooms installed as part of this work. Automatic timed system shutdown shall be configured as part of this software. Shutdown time(s) to be coordinated with Owner.

B. Software: All versions shall be current as of date of substantial completion.

C. Aesthetic Requirements

1. Printing: Button labels shall be engraved where applicable, or machine-printed where no engraved button/bezel is available. Handwritten labels are not acceptable.

2. Graphics: Icons and graphic representations of equipment and functions shall be crisp, sharp, and easy to identify. Icons shall be used wherever possible.

3. Text: ICS screens shall not use uncommon abbreviations. Text shall be sans serif and shall be sized to be clearly readable.

D. IT Coordination

1. General: Where connection between components or control features are accomplished over the Owner’s LAN, Contractor shall coordinate with Owner’s IT department for IP/MAC addresses, firewall access, and other issues pertaining to successful integration.

2. Permission: It is the Contractor’s responsibility to obtain necessary information and permissions to implement their system. Any delays or problems with gathering information or coordinating access to the LAN or WAN shall be brought to Consultant immediately for resolution.

E. Ownership

1. General: Upon completion of the project, all programming and configuration of control hardware, touch panels, and other devices shall be property of Owner.

2. Property Rights: Contractor assigns to Owner any and all intellectual property rights and applications made by Contractor, or its agents or employees in connection with the performance of this contract. Contractor also acknowledges and agrees that services rendered in connection with the performance of this contract shall be a “work made for hire” within the meaning of Section 201 inventions of the Copyright Law of 1976.

3. No Passwords: Contractor shall not use any passwords to prevent access to code files except as specified herein.

F. Configuration

1. Contractor shall configure software to meet all functional requirements.
2. Contractor shall make adjustments to programming as required by Consultant up to issuance of substantial completion punch list at no additional charge, so long as changes relate to equipment in this bid package.

2.17 Misc. Parts & Materials

A. General Information: As required by Sections 27 00 00 and 27 40 00.

B. Interconnections: Contractor shall be responsible for providing populated, grommeted, or blank cover plates for all wall and floor box openings intended for audiovisual systems.

C. Twisted Pair (TP) Category Cabling: Contractor shall use twisted pair Category cable as recommended by manufacturer of transmission equipment for optimal bandwidth and signal timing. Where cable type is not specified by manufacturer, Contractor shall use shielded twisted pair Category 6 cabling. Cable type shall be detailed in pre-construction submittals with any deviations from manufacturer recommendations expressly noted.

D. Mounts: Contractor shall fabricate mounts for projectors, monitors, loudspeakers, cameras, etc. as necessary, and shall modify standard mounts as required for optimal mounting configurations. Intended hardware shall be detailed in shop drawing submittals.

1. Custom mounting configurations shall be submitted in shop drawings for review.

2. Contractor shall provide all hardware as necessary, including flanges, Unistrut, threaded pipe, column extensions, yokes, clamps, threaded rod, aircraft cable, and any other hardware required to securely mount equipment.

3. All ceiling tile penetrations shall be neatly finished with a plate, grommet and/or escutcheon ring.

E. Laptop Cables: Contractor shall provide all interconnection cables shown on the project drawings, including breakout cables for laptops. Laptop breakout cables shall have integrated audio, where applicable, and shall be equal or greater in quality to the Extron 26-490-series and Extron 26-650-series of cables. Substitutions are subject to prior Consultant approval.

F. Keys: Keys for like equipment shall be identical.

G. Wireless Transceivers: Where wireless transceivers are specified (including, but not limited to wireless microphones, wireless assistive listening devices, etc.) Contractor shall verify frequency band range of existing Owner wireless systems. Contractor shall provide wireless transceiver system(s) compatible with existing equipment for interoperability.

H. Cable Sleeving:

I. Shall be black expandable sleeving, with ends neatly turned under 2”, held in place either by nylon tie-wrap, or heat-shrink tubing. Tie wraps, if used, shall not deform cables within the umbilical. Cables requiring sleeving include:

1. Exposed cabling outside of wire management in console furniture.

2. Cable umbilicals connecting to or from wall, floor, or ceiling plates consisting of more than one wire.

J. Contractor shall coordinate as necessary so that all low-voltage cabling (including Ethernet) are included in a single umbilical.
Part 3 - Execution

3.01 Testing
   A. Refer to Section 27 00 00 for additional requirements.

3.02 Training
   A. Refer to Section 27 00 00 for additional requirements.

3.03 Warranty
   A. Refer to Section 27 00 00 for additional requirements.

3.04 Equipment Location
   A. Coordination: Where device locations are not shown on rack/console elevations and project drawings, Contractor shall coordinate with Consultant to identify desired/optimal locations.
   B. Contractor shall verify all wall-mounted monitor mounting heights on preconstruction submittals.

3.05 Equipment Configuration
   A. Integrated Control System (ICS): Refer to Section 27 41 70 for ICS configuration.
   B. Labeling: Contractor shall configure all equipment for normal use, including setting of levels and presets. Small adhesive labels shall be affixed to equipment indicating nominal levels and settings.
   C. EDID, E-EDID: Where devices allow for the customization of EDID information, Contractor shall configure EDID settings of all applicable devices such that the audiovisual system is optimized.

3.06 System Testing
   A. Contractor shall check that all cables are properly labeled and secured prior to substantial completion inspection.
   B. Contractor shall ensure that all work areas are clear of all debris, tools, empty boxes, and extra parts prior to substantial completion inspection.
   C. Prior to the substantial completion inspection, Contractor shall notify the Consultant that all items listed below are complete:
      1. Contractor shall ensure that all standard functions of equipment are functional.
      2. Contractor shall verify all input and outputs of the system for signal quality.
      3. Audio: Contractor shall verify all sources are free of destructive noise (excessive noise floor, hiss, grounding interference) and that speakers function properly. The audio system shall be consistent in terms of volume and tone and shall be optimized for the space(s) served by the audio system.
      4. Video: Contractor shall verify that all EDID and EDID-D information has been configured at each video transmission and processing device. Where signal processing is present, Contractor shall optimize the video system to native resolution of display devices.
3.07 Training

A. General Information: As required by Sections 27 00 00 and 27 40 00.

B. Contractor shall provide one (2) 60-minute training sessions for each unique audiovisual room type. Training sessions shall comprise of one half of the time dedicated to instructor led training with the remainder of the session to be used for instructor supervised hands-on end user operation of the system(s):

1. Identification of input locations, source devices, control locations, displays, and other devices requiring end user interaction for successful system operation.
2. Use of control system.
3. Use of source devices and input locations.
4. Switching inputs for each display.
5. Training shall include operation of system in event of control system malfunction – all manual switching and use of remotes.
6. Basic troubleshooting for common user errors.

C. Scheduling: Training shall be scheduled with Owner at least ten (10) days in advance.

D. Quick-Reference Guides: Contractor shall compile quick-reference guide for system operation and basic troubleshooting. Quick-reference guide shall be provided at the training session, and training shall include walking through quick-reference guide steps.

End of Section
Part 1 - General

1.01 Scope
   A. Provide new distributed communications systems devices as shown on plans that tie in into the existing public address system located on campus. The existing system is to be expanded as necessary to accommodate new devices. Not all components listed within spec will be required. Refer to technology floorplans for exact requirements.

1.02 Related Work
   A. Section 27 00 00 – General Technology Requirements
   B. Section 27 05 00 – Communications General Requirements
   C. Section 27 05 23 – Pathways for Technology Systems
   D. Section 27 05 26 – Grounding and Bonding for Technology Systems
   E. Section 27 11 00 – Communications Equipment Rooms
   F. Section 27 15 00 – Communications Horizontal Cabling
   G. Section 27 16 00 – Communications Connecting Cords
   H. Section 27 18 00 – Communications Labeling and Identification
   I. Section 27 60 00 – Physical Security General Requirements
   J. Section 27 62 00 – Electronic Access Control System
   K. Section 27 64 00 – Video Surveillance System
   L. Section 27 66 00 – Intrusion Detection System

1.03 Definitions
   A. Refer to Section 27 00 00 for additional requirements.

1.04 Reference
   A. In addition to any requirements below, Contractor shall abide by requirements delineated in 27 00 00 and 27 40 00 including but not limited to:
      1. General: Definitions, reference standards and codes, qualifications, pre-construction submittals, construction progress submittals, closeout submittals, and correction period.
      2. Products: Substitutions, product specifications, miscellaneous material, cable, connectors, power devices, and interface panels.
      3. Execution: Coordination, testing, training, warranty, and cable management.

1.05 Qualifications
   A. Refer to Section 27 00 00 for additional requirements.
B. Training: Programmer shall have received manufacturer-provided and/or manufacturer approved training in the configuration of the distributed communications system(s) being provided.

C. Certification: Programmer shall hold the highest applicable manufacturer programming certification(s) offered by the manufacturer(s) of the distributed communications system(s) hardware.

D. Submittal: Certification certificate shall be submitted with distributed communications system(s) submittals.

1.06 Pre-Construction Submittals

A. Refer to Section 27 00 00 for additional requirements.

1.07 Pre-installation Procedures

A. Refer to section 27 00 00 for additional requirements.

1.08 Construction Progress Submittals

A. Refer to Section 27 00 00 for additional requirements.

1.09 Closeout Submittals

A. Refer to Section 27 00 00 for additional requirements.

1.10 Mounting and Installation

A. Contractor shall provide the appropriate mounting hardware for all ceiling types and wall types where devices will be located.

B. Exterior devices shall be installed in a sealed backbox with a weather hood.

1.11 Code and Standard Requirements

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association and any other codes as required by the AHJ.

B. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

C. Other applicable codes and standards are as follows:

2. NFPA 70 – National Electrical Code
3. TIA/EIA 568-C-1, 2, 3 Standards
Part 2 - Products

2.01 System Manufacturer

1. Contractor is to expand upon existing PA/Bell/Clock systems at each campus as necessary to provide a fully functional system.

2. Existing PA systems:
   a. Telecor:
      i. Dessau Middle School
      ii. Connally High School
   b. Bogen
      i. Parkcrest Middle School
      ii. Hendrickson High School
      iii. Weiss High School
   c. Rauland
      i. Pflugerville Middle School
      ii. Westview Middle School
   d. Dukane:
      i. Kelly Lane Middle School
   e. AMX:
      i. Cele Middle School

2.02 Call Button

A. Classroom and Office Call-In Buttons, shown as “CB” shall be wall mounted, generally, by the door and shall activate an audible alert at the front office console. The Call-in buttons shall be capable of initiating Normal and Emergency/Urgent calls from the Classroom/Office to the front Admin Office, the console shall provide for calling room identification

B. Call buttons shall support a ‘Check-In’ feature to indicate that the room is safely secured during an emergency.

C. The Classroom Call-In Button, when activated, shall sound an audible alarm in the front office area and provide visual feedback of type of call and location of call

2.03 Speaker Wiring

A. Local room wiring for speakers and call button shall be cabled with 18AWG stranded cable. Homeruns between headend and room zones shall use a minimum of 16AWG stranded twisted pair cable.

B. Common area loudspeaker zones shall have no more than 25 loudspeakers per homerun zone and be fed with a minimum of 16AWG stranded twisted pair cable.
C. Classroom loudspeakers shall be a single voice-coil type with the voice-coil connected to a 25V constant voltage audio transformer. Each classroom loudspeaker shall be taped at a minimum of 2 Watts. Classroom Loudspeakers shall be lay-in ceiling grid 2’ x 2’ typical.

D. Common Zone loudspeakers shall be a single voice-coil type with the voice-coil connected to a 25V constant voltage audio transformer. Each loudspeaker shall be taped at a minimum of 2.5 Watts. Common area Loudspeakers shall be lay-in ceiling grid 2’ x 2’ typical.

2.04 Loudspeaker Types

A. Every loudspeaker location on the plans is indicated by a speaker type “S#” that corresponds to a specific speaker model. Provide locations as indicated on the plans and models as indicated in the loudspeaker schedule on one of the technology details sheets.

Part 3 - Execution

3.01 Testing

A. Refer to Section 27 00 00 for additional requirements.

3.02 Paging Zones

A. Contractor shall install paging system using the following zones:
   1. Classroom (each one an independent zone, with virtual zones for classroom wings)
   2. Hallway
   3. Exterior (each major wall/exterior area zoned separately)
   4. Offices
   5. Cafeteria
   6. Kitchen
   7. Gymnasium
   8. Community Room
   9. Library

B. Confirm final zones with Owner prior to installation and again before system programming/configuration.

3.03 Aesthetics

A. All cables and equipment terminating at panels frames shall be vertically straight, with no cables crossing each other, from twelve inches inside the ceiling area to the termination block.

B. All cable bundles shall be combed and bundled to accommodate individual termination block rows and panels.

C. All surface-mounted devices shall be firmly secured level and plumb

D. All rack mount equipment shall be securely installed.
3.04 Procedures & Methods

A. The Contractor shall provide rack shelves or rack mounting ears for any equipment that is not rack mountable. All equipment installed using shelves shall be fastened to the rack shelf. If Velcro is used to fasten any equipment, the Velcro must be fastened with screws. Adhesive is not an acceptable means to fasten any equipment.

B. Supplementary equipment within equipment racks, such as special assemblies that are not rack mountable or fastened to rack shelves shall be mounted on painted black high grade wooden boards running vertically on side rails of equipment racks. The same wooden strips shall also be used to support cable tie support bars for lacing cables to equipment.

C. Equipment shall be mounted into racks and consoles, and fully wired and tested, before delivery to job site.

D. Equipment and enclosures shall be mounted plumb and square in relation to the structure.

E. Devices, wire raceways, and equipment, except for portable equipment, shall be permanently attached to equipment racks or building structure and held firmly in place with screws or fasteners. Adhesives alone shall not be accepted as fasteners.

F. All equipment mounting boards in head-end rooms, MER’s, electrical, or TR closets shall be painted white or black as location dictates with fire retardant paint. The mounting boards shall be made of high-grade plywood.

3.05 Wire & Cable Requirements

A. Cable installation must follow related TIA/EIA standards and recommendations, including methodology as noted in TIA/EIA 569 - Part 4.6 Ceiling Pathways. Specifically, including sections 4.6.1 General, 4.6.2 Design Guidelines, and 4.6.5 Cable Support.

B. All equipment rack wiring and cabling shall be neatly laced, ends dressed with heat shrink tubing, and all cables shall have service loops between the horizontal tie bar and the connection to equipment. Rack cabling shall be adequately supported with tie wraps or Velcro wire wraps and horizontal support bars to rack frame as it enters or exits the front or back of equipment.

C. There shall be no unmarked cables at any place in any part of any system this includes both in equipment racks and outside of equipment racks. Label markings codes used on cables shall correspond and be shown clearly on as built drawings

D. All cables shall be separated into like groups according to signal or power levels and routed separately to eliminate signal contamination and cross-talk, this includes both in equipment racks and outside of equipment racks.

E. All power cables, control cables, and high level cables shall be grouped to one side of the equipment rack while low level cables shall be grouped to the other side.

F. All cables within equipment racks will use Velcro wire wraps to manage and bundle cables. Velcro strips will be no more than a ¼" wide.

G. All cabling located above ceilings shall be tied off to and supported by ceiling supports or other structures at a minimum of eighteen inches above the ceiling.

H. Cabling shall be placed in conduit where exposed in gym roof joist. Exposed cables shall not be allowed.
3.06 Equipment and Cable Labels

A. All cables, regardless of length, shall be marked with indelible color-coded labels that have unique identifying number that corresponds with those found on the schematic diagrams and as-built drawings.

B. Labels shall be directly hot stamped or factory-stamped with closed sleeve method. Adhesive strip labels may only be used if protected by transparent heat-shrink tubing.

C. Marking codes used on cables shall correspond and be shown clearly on as-built drawings.

D. Provide all proposed wording and/or numbering scheme for labeling to the Consultant for review and written approval prior to procurement or installation.

E. All wall plates shall be labeled with Input and Output identifications and referenced to corresponding operational software or hardware it serves.

F. All labels used must be permanent and secure. Provide labeling as follows unless otherwise noted in a specific section:

1. Provide engraved Lamaco labels at the front of all equipment mounted in the racks. Labels shall indicate equipment type and model number and correspond to the As-Built drawings for equipment identification.

2. Mount labels on the equipment rack, not on the equipment, and attach in a neat, plumb, and permanent manner. The labels shall be placed on the equipment rack vertical frame (post). If the equipment rack vertical posts have a recessed mid-section, then match label width to fit this recessed section.

3. Labels shall be uniform in size. All adjacent labels shall be sized to match the other labels used for same purpose. Similarly, provide engraved labels of like size in other locations.

4. Provide engraved Lamaco labels on each equipment rack rear door or console rear panel reading "No user serviceable parts. Refer service to qualified technician."

5. Embossed adhesive labels are not acceptable.

6. All label lettering shall be a minimum of .08" high. Embossed adhesive labels are not acceptable.

7. Position at the left side front top rack space of each equipment cabinet a label that states the name of system Installer with contact information and at the right side a label that states the Design Consultant with contact information.

8. Unless otherwise noted, labels on dark panels shall be black with white letters. Labels on stainless steel or brushed natural aluminum plates or light colored panels shall be white with black lettering.

9. All wall plates shall have input and output connectors labeled in a professional and permanent manner, no hand written labels shall be accepted.

10. Cable and Jack labels shall include room identification with unique cable number, jack location within the room, and MER or TR number.

11. The Contractor shall use actual room identifications in their labeling scheme. Contractor shall obtain written approval from the Owner for the actual room numbers, and labeling scheme, to be used prior to installation.
12. Switches, connectors, jacks, receptacles, outlets, cables and cable terminations shall be logically and permanently marked in a manner approved by the Consultant.

13. Custom panel nomenclature shall be engraved, etched, or screened. Markings for these items are purposely detailed in the construction drawings to ensure consistency and clarity. Verify markings and placement with the Consultant prior to procurement. Submit label sample layouts for Project Consultant’s review.

14. All terminal blocks, rack mounted equipment, and active slots of card frame systems shall be clearly and logically labeled in a manner acceptable to the Consultant.

15. All labeling information shall appear on the As-Built drawings as device and equipment cross-reference identifier and servicing aids.

3.07 Connections and Connectors

A. Connections shall be made with approved connectors on cables, terminal blocks, or punch blocks. Crimp style connectors shall be made with proper crimping tool. Two point crimps will not be accepted.

B. RF cable connectors shall be made with hex crimp.

C. Cables shall be terminated with the proper connector specifically produced for use with each type of cable.

D. Video connectors that are not of solder type (HDMI, BNC, RCA, F, etc.) shall be terminated using a crimp tool or dies designed specifically for the connectors being applied.

E. XLR type connectors shall be wired with pin 2 high, pin 3 low, and pin 1 shield.

F. Mechanical connectors must be specially made for type of cable or wire used.

G. Connector adapters will not be allowed in any part of the system.

H. Twist on connectors shall not be allowed.

I. Solder joints will be made with rosin-core solder.

3.08 Interconnection

A. Contractor shall make all system interconnections as necessary for a fully functional system that meets the requirements of the drawings and specifications.

B. Contractor shall provide power and control cables to and from power supplies, remotely controlled equipment and other devices even though such cables are not explicitly indicated on Drawings or listed in equipment tables.

3.09 Cable Management

A. Cabling located above ceilings shall be tied off to and supported with cable hangers fastened directly to the structure.

B. Where a cable is installed inside desk or other furniture, a means of protecting the cables and holding cabling to a fixed surface shall be provided.

C. Holes in horizontal furniture surfaces for cable pass-through shall be provided with appropriate sized grommet. Grommet shall be black unless otherwise specified.
D. Provide Service Loops with ample cable at each termination so that plates, panels, and equipment can be removed for service, re-termination or inspection. Provide the following as a minimum:

1. Wall plate outlet box: minimum of ten (10) inches from wall surface to jack.
2. Termination panel: Six (6) inches behind termination panel from cable tie to jack.

3.10 Equipment Racks

A. Install all rack-mounted equipment using steel 10-32 machine screws with Phillips large oval heads or Allen head drives. Screws must have a black oxide finish, and plastic cup washers to protect the equipment panel finish.

B. Provide wire and cable management at the front of equipment and wire and cable support bars at the rear of equipment. Support bars will be used to tie cables for strain relief before connection to the accompanying equipment. Provide sufficient service loops between support bars and equipment.

C. Unused open front rack spaces in equipment racks must be filled with black rack blank spacers (not vents). Equipment rack vents shall only be used at top and bottom of the rack.

D. Place all rack devices requiring adjustments, cleaning, or similar attention so that they will be accessible for such attention.

E. Equipment racks shall be positioned to permit full access for operation and service. This means clearance for door swing and service technician at both front and back of equipment rack.

F. Equipment racks and sensitive components shall be placed so that signals will not be contaminated by induced electromagnetic and electrostatic noise from other electrical devices.

G. All wire and cable to and from the equipment racks shall run across the top of the racks on a ladder cable tray mounted with standoffs from the equipment rack or hung below the ceiling.

H. As a general practice, all power cables, control cables, and high level cables shall be grouped to one side of the equipment rack while low-level cables are on the other side.

3.11 Testing and Adjusting

A. The Contractor will be responsible for adjusting the installed system and notifying the Consultant when system adjustments have been completed:

1. In accordance with Construction Documents
2. As required, to provide the Owner a fully functional system at system turnover
3. As directed by the Consultant

B. Audio System Equalization

1. Using a Real-Time audio frequency spectrum analyzer, such as Audio Control SA-3052 or equivalent, with both 1/3 band and narrow band display, equalize all loudspeaker systems to provide a suitable frequency response as follows:

   a. Flat from 60 Hz to 2 kHz + or − 1-1/2db with a 1db per 1/3 octave roll off after 2K
b. Load and save the final normal settings in the DSP as preset one and record same settings including system gain and amplifier level settings in the As-Built Project Manual

C. Notification: When above tests have been completed and system is ready for inspection, notify Consultant in writing at least seven working days prior to inspection. Include in this notice copies of all data recorded, date each test was completed and results of each test. All test data shall be available during inspection process.

3.12 Demonstration

A. The final acceptance, with proof of performance and operational verifications for the installed Audio & Video Systems shall be the responsibility of and performed by the Contractor in the presence of the Consultant and Owner's representative.

B. Final acceptance shall be in accordance with Construction Documents, General Conditions, and Division 27 Technology General Requirements.

C. The Contractor shall notify the Consultant 10 day’s prior substantial completion and intended schedule for the final acceptance walkthrough demonstration.

D. Acceptance Testing shall include, but not be limited to the following:
   1. Demonstration of all system operations to the Consultant as the Owner's representative.
   2. A minimum of two (2) installation technicians provided by the Contractor to assist the project Consultant, as required, during final test verification and final acceptance demonstration.

E. The technicians shall be equipped to perform necessary corrections to the system. They Contractor shall provide test equipment capable of testing any and all parts of the equipment, cabling, or systems.

F. The minimum required test equipment shall include but not be limited to the following:
   1. Three (3) two-way radios, that covers the area of testing, for communications between Contractor and Consultant
   2. Multi test meter for reading AC / DC Voltage, Amperage, Resistance, and continuity
   3. Sound level meter calibrated in db with A, C, and flat filters
   4. Audio Tone Generator and audio signal tracer
   5. Calibrated Pink Noise Generator
   6. Real Time Audio Analyzer (RTA)
   7. Audio acoustical pulse polarity / phase tester
   8. Computer with installed device software and connecting cables, example DSP

G. The Contractor shall be responsible for equipment adjustments to ensure normal and proper operation. Owner required system adjustments will be made by the Contractor as directed by Owner or Project Consultant during final testing

H. During the final acceptance walkthrough the Contractor shall demonstrate operation of each major component and functional requirement as specified herein.
I. If any portion of the system does not appear to be functioning properly during the final acceptance walkthrough the Contractor shall do further test, along with corrective actions that may be immediately possible. If the need for further corrections or corrective actions does not resolve the issue the demonstration, at the Consultant’s discretion, shall be discontinued until the system operates properly.

J. The Contractor shall remain responsible for all equipment, labor, hardware and documentation, in part and in total, until Owner accepts such work or material in writing.

End of Section
1.01 Scope
   A. Refer to Section 27 00 00 for additional project scope information.
   B. This section describes the general product and execution requirements related to furnishing and installing Physical Security Systems. Physical Security Systems includes Video Surveillance, Electronic Access Control, Intrusion Detection, and their sub systems.
   C. Provide new security devices as shown on plans that tie into the existing security systems located on campus. The existing systems are to be expanded as necessary to accommodate new devices.
   D. Contractor shall provide low voltage power and control lines to and from power supplies, remotely controlled equipment, and other devices, even though not explicitly indicated on drawings or listed in equipment tables.
   E. Contractor shall be, or Contractor shall provide, an Electrical Contractor for provision of high voltage power and conduits/raceway, where necessary.
   F. Contractor shall be responsible for any and all related programming and end-user training unless noted otherwise.

1.02 Related Work
   A. Section 27 00 00 – General Technology Requirements
   B. Section 27 05 00 – Communications General Requirements
   C. Section 27 05 23 – Pathways for Technology Systems
   D. Section 27 05 26 – Grounding and Bonding for Technology Systems
   E. Section 27 11 00 – Communications Equipment Rooms
   F. Section 27 15 00 – Communications Horizontal Cabling
   G. Section 27 16 00 – Communications Connecting Cords
   H. Section 27 18 00 – Communications Labeling and Identification
   I. Section 27 51 00 – Distributed Communications Systems
   J. Section 27 62 00 – Electronic Access Control System
   K. Section 27 64 00 – Video Surveillance System
   L. Section 27 66 00 – Intrusion Detection System

1.03 Definitions
   A. Refer to Section 27 00 00 for additional definitions.
1.04 Reference Standards and Codes

A. Refer to Section 27 00 00 for additional requirements.

1.05 Qualifications

A. Refer to Section 27 00 00 for additional requirements.

B. Training: Programmer shall have received manufacturer-provided and/or manufacturer approved training in the configuration of the physical security system(s) being provided.

C. Certification: Programmer shall hold the highest applicable manufacturer programming certification(s) offered by the manufacturer(s) of the physical security system(s).

D. Submittal: Certification certificate shall be submitted with physical security system(s) submittals.

1.06 Pre-Construction Submittals

A. Refer to Section 27 00 00 for additional requirements.

B. Hardware, Application Software, and Network Requirements: A system description including analysis and calculations used in sizing equipment required by the Physical Security Systems. The description shall show how the equipment will operate as a system to meet the performance requirements of the systems. The following information shall be supplied as a minimum:

1. Server(s) processor(s), disk space and memory size
2. Workstation(s) processor(s), disk space and memory size
3. Operating System(s) Software, where software is provided or upgraded
4. Application Software, with Optional and Custom Software Modules supplied in this project
5. Integration Schemes: Proposed connectivity, software, development requirements, and SDK information, for inter-system communication.
6. Network reliability requirements
7. Number and location of LAN ports required
8. Number of IP addresses required.
9. Other specific network requirements, preferences, and constraints
10. Backup/archive system size and configuration
11. Start-up operations
12. Description of site (field) control equipment (Controllers/Field Panels) and their configuration
13. Access control power calculations.
14. Battery backup requirements
1.07 Construction Progress Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.08 Closeout Submittals
   A. Refer to Section 27 00 00 for additional requirements.
   B. Quick-Reference Guides: Contractor shall create a concise quick-reference guide covering normal system operation and basic troubleshooting procedures for each room/system type. Length of each quick-reference guide shall be commensurate with the information needed for successful operation, subject to Owner approval.
      1. Upon Owner approval, Contractor shall provide two (2) laminated copies and one (1) digital copy for each room/system type.
   C. Serial Numbers: Contractor shall provide a list of serial numbers for all supplied components with serial numbers and with a unit price greater than $99. Organize list by room/system type.

Part 2 - Products

2.01 Substitutions
   A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 KVM
   A. The contractor shall provide a KVM for each rack or cabinet housing a server or multiple servers including servers for access control.
   B. The KVM shall have a 19” monitor with integrated mouse pad and keyboard.
   C. The KVM shall have video inputs and USB connectors with 8 ports.
   D. The KVM shall be IP enabled for remote management.
   E. The contractor shall provide with a 4-post to 2-post converter (CPI #12751-719 or equal) when mounted to a 2-post rack.
   F. Tripp-lite B020-U08-19-IP
      1. Or approved equal

2.03 Refer to individual sections for additional product information.

2.04 Fire Stopping Materials
   A. Refer to Section 27 00 00 for additional requirements.
Part 3 - Execution

3.01 Network Time Protocol (NTP) Synchronization

A. All security systems as well as additional integrated systems such as intercom/PA, SQL/database servers and data logging servers shall synchronize to a common NTP server.

B. All systems including servers and workstations shall be within 50ms of each other or less depending on specific system requirements such as failover. The synchronization frequency shall be no less than every 3 hours.

C. The Contractor shall coordinate with the Owner for a NTP server connection. The Contractor shall verify the accuracy of the Owners NTP server before utilizing it.

D. When a reliable NTP server is not available from the Owner the Contractor shall not utilize the built in Microsoft Windows NTP servers or registry tweaks shall not be utilized. The Contractor shall use software such as NetTime (www.timesynctool.com) installed on the appropriate server.

E. Workstations on the private security network shall have an NTP client such as NetTime operating as a Windows service to sync the workstations clock to the same NTP server as the rest of the security systems.

F. When an external internet connection is not available the Contractor shall provide a GPS based NTP server such as the Veracity Timenet or equal.

3.02 Testing

A. Refer to Section 27 00 00 for additional requirements.

3.03 Training

A. Refer to Section 27 00 00 for additional requirements.

B. On-Site Training

1. General: Present, review and describe equipment and materials to the Owner and Owner’s operating personnel and fully demonstrate the operation and maintenance of the systems, equipment and devices specified herein.

2. Include with new systems, Contractor to arrange and provide for video recording of each onsite training session.

   a. Provide professional video and audio recording of each software screen option with Owner approval of content.

   b. Provide end user video recording for all training levels.

3. Training shall comprise two separate levels of training;

   a. User Group upon substantial completion of the project.

      i. User group training shall include a site/building walk through indicating locations of equipment and their usage.

      ii. User group training shall include the operation of workstation capability of system monitoring, command override and report generation.
b. Maintenance Group upon completion of the project prior to close out.
   i. Maintenance group training shall include a site/building walk through indicating locations of equipment and their usage at up to six representative sites.
   ii. Review of a-build documentation at each controller location.
   iii. Troubleshooting techniques in hardware and software.

4. The training shall cover the overall system, each individual system, each subsystem, and each component. The training shall also cover procedures for database management, normal operations, and failure modes with response procedures for each failure. Each procedural item shall be applied to each equipment level.

C. Duration: Refer to the individual sections for the minimum time requirements.

3.04 Warranty

A. Refer to Section 27 00 00 for additional requirements.

B. Furnish and guarantee maintenance, repair and inspection service for the system using factory trained authorized representatives of the manufacturer of the equipment for a period of one year after final acceptance of the installation.

C. Third Party Device warranties are transferred from the manufacturer to the Contractor, which may then transfer third party warranties to the Owner. Specific third party warranty details, terms and conditions, remedies and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are directly interconnected to the field hardware or computers and are purchased directly from the manufacturer.

D. Purpose

1. The Contractor shall repair any system malfunction or installation deficiency discovered by the Owner or their representatives during the burn in and warranty period.

2. The Contractor shall correct any installation deficiencies found against the contract drawings and specifications discovered by the Owner or their representatives during the warranty period.

3.05 Examination of Site and Documents

A. Bidder shall examine all documents, shall visit the site(s) prior to submitting proposal, record their own investigations, and shall inform themselves of all conditions under which the Work is to be performed at the site(s) of the Work, including the structure of the ground, the obstacles that may be encountered, and all of the conditions of the documents, including superintendence of the Work, requirements of temporary environmental controls, the time of completion, list of Subcontractors, and all other relevant matters that may affect the Work or the proposal process.

B. Verify cable lengths comply with published standards.

C. Notify Owner/Consultant of installation that would exceed maximum lengths prior to installation of cable.

D. Contactor shall consult with Owner/Consultant regarding alternative routing or location of cable.
E. Do not proceed until unsatisfactory conditions have been corrected.

F. Failure to make the examination shall not result in any Change Order requests.

G. The Bidder shall base the proposal on the site(s) examination, materials complying with the plans and specifications and shall list all materials where the proposal form requires.

H. The commencement of work by the Contractor shall indicate acceptance of existing conditions, unless a written notice of exceptions has been provided to the Owner/Consultant prior to commencement.

I. If the Contractor observes, during preliminary examinations or subsequent work, existing violations of fire stopping, electrical wiring, grounding, or other safety- or code-related issues, the Contractor shall report these to the Owner/Consultant in a timely manner.

3.06 Installation Requirements

A. Refer to Section 27 00 00 for additional requirements.

B. Contractor shall furnish and install all cables, connectors, and equipment as shown on Drawings and as specified herein.

C. It is the Contractor’s responsibility to survey the site and include all necessary costs to perform the installation as specified. This includes any modifications required to route and conceal horizontal distribution wiring.

D. Beginning installation means Contractor accepts existing conditions.

E. The Contractor shall be responsible for identifying and reporting to the General Contractor any existing damage to walls, flooring, tiles, and furnishings in the work area prior to start of work. All damage to interior spaces caused by the installation of cable, raceway, or other hardware shall be repaired by the Contractor.

F. Repairs shall match preexisting color and finish of walls, floors, and ceilings. Any Contractor-damaged ceiling tiles, floor, and carpet shall to be replaced to match color, size, style, and texture.

G. Where unacceptable conditions are found, the Contractor shall bring this to the attention of the construction supervisor immediately. A written resolution will follow to determine the appropriate action to be taken.

H. All wiring shall be run “free-air,” in conduit, in a secured plastic raceway or in modular furniture as designated on the Drawings. All cable shall be free of tension at both ends. PLENUM rated cable shall be used in areas used for air handling.

I. Avoid abrasion and other damage to cables during installation.

J. The cable system will be tested and documented upon completion of the installation as defined in the section below.

K. All manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by manufacturers or as indicated in their published literature, unless specifically noted herein to the contrary.
3.07 Cooperation

A. The Contractor shall cooperate with Consultant’s and Owner’s personnel in locating work in a proper manner.

B. Should it be necessary to raise, lower, or move longitudinally any part of the work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

3.08 Commissioning Submittals

A. Provide the following to the Owner no later than 30 days prior to system commissioning/programming.


2. Software: One set of fully functional software in manufacturer’s original media packaging, temporarily licensed for a 30-day evaluation period.


3.09 Commissioning

A. Provide programming and commissioning for each system as described in individual sections below.

B. This Contractor shall develop and submit a plan for coordination of settings and programming issues with the Consultant and Owner no later than 30 days prior to performing programming and commissioning.

C. The security Contractor is required to place entire system into full and proper operation as designed and specified.

D. Verify that all hardware components are properly installed, connected, communicating, and operating correctly.

E. Verify that all system software is installed, configured, and complies with specified functional requirements.

F. Perform final acceptance testing in the presence of Owner’s representative, executing a point-by-point inspection against a documented test plan that demonstrates compliance with system requirements as designed and specified.

1. Submit documented test plan to Owner at least 14 days in advance of acceptance test, inspection, and check-off.

2. Conduct final acceptance tests in presence of Owner’s representative, verifying that each device point and sequence is operating correctly and properly reporting back to control panel and control center.

3. Acceptance by Owner is contingent on successful completion of check-off; if check-off is not completed due to additional work required, re-schedule and perform complete check-off until complete in one pass, unless portions of system can be verified as not adversely affected by additional work.
4. The system shall not be considered accepted until all acceptance test items have been successfully checked-off. Beneficial use of part or all of the system shall not be considered as acceptance.

3.10 Operation and Maintenance Manuals

A. Part One: Notwithstanding requirements specified elsewhere, submit the following labeled as the "Operating and Maintenance Manual" within thirty (30) days after Final Acceptance of the Installation:

1. Record Drawings: Submit two (2) copies of revised versions of drawings as submitted in the "Shop and Field" and "Equipment Wiring Diagrams" Submittals showing actual device locations, conduit routing, wiring and relationships as they were constructed. Include nomenclature showing as-built wire designations and colors. Drawings shall include room numbers coinciding with Owner space planning numbering. Drawings shall be submitted in electronic editable AutoCAD 2010 files, in ".dwg" format, on CD or DVD disks.

2. Manuals: Submit two (2) copies of each of the following materials in bound manuals, or electronic PDF copies, with labeled dividers:
   a. A final Bill of Material for each system
   b. Equipment Instruction Manuals: Complete, project specific comprehensive instructions for the operation of devices and equipment provided as part of this work.
   c. Manufacturers Instruction Manuals: Specification sheets, brochures, Operation Manuals and service sheets published by the manufacturers of the components, devices and equipment provided.
   d. Include information for testing, repair, troubleshooting, assembly, disassembly and recommended maintenance intervals.
   e. Provide a replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
   f. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.
   g. Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturer’s Warranty Registration papers as described herein.

B. Part Two: Within fourteen (14) days of receipt of Consultant reviewed Operating and Maintenance Manual (Phase One), submit three (3) electronic copies in AutoCAD 2010 editable .dwg format of the reviewed Record Drawings and three (3) copies of the reviewed Operating and Maintenance Manuals to the Owner, on CD or DVD disks.

1. Within each equipment enclosure and/or terminal cabinet, the Contractor shall place a Single Line drawing of the system(s) and the respective Terminal Cabinet Wiring Diagram in a clear plastic sleeve permanently attached to the inside cover of the terminal cabinet.

2. In each equipment enclosure the Contractor shall place a drawing providing device locations served by the equipment within the enclosure with identification that is identical to the wiring tags and with the software description of each point.

3. The Contractor shall provide to the Owner one (1) copy of new administration and user software, including required graphical maps, on CD or DVD disks.
C. Sufficient information, (detailed schematics of subsystems, assemblies and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.

3.11 Closeout Procedures

A. Notification: Contractor shall provide written notification to Architect/Consultant and Owner when Contractor is satisfied that the work has been completed and is ready for inspection.

B. Closeout Submittals: Contractor shall provide closeout documentation to the Architect/Consultant. The Architect/Consultant shall receive the closeout submittals no less than 72 hours prior to the scheduled inspection time.

C. Inspection: Contractor shall be present for the inspection by the Architect/Consultant. Contractor shall supply all testing equipment needed to verify compliance with the specifications found in Bid package.

D. Punch List: Work or materials found to be incomplete, of unsatisfactory quality, failing to meet the specifications in the Bid package, and/or unacceptable to the Architect/Consultant shall be documented by the Architect/Consultant and provided to Contractor to rectify.

E. Re-Inspection: If a re-inspection is necessary, the costs of the Architect/Consultant’s additional travel, hours, and expenses may be deducted by the Owner from the contract amount due Contractor.

F. Punch List Approval: The punch list shall be considered complete only after having been signed by the Owner and Architect/Consultant.

G. The system has successfully completed a 30-day performance period.

H. Payment Authorization: Final payment will be authorized only after all closeout procedures and requirements have been followed and fulfilled by Contractor and approved in writing by the Owner and Architect/Consultant, including punch list(s) and/or re-inspection(s).

3.12 Service Contract

A. The service contract shall cover equipment and software related to this contract, and shall provide for the following parts and services, without additional cost to the Owner:

1. Bi-yearly inspections, preventative maintenance and testing of equipment and components in Year One of the warranty period.

2. Annual inspections, preventive maintenance, and testing of equipment and components in Years Two and above of the warranty period.

3. Regular Service, Emergency Service, and Call-Back Service

4. Labor and Repairs

5. Equipment, and Materials and transportation cost.

B. Response Time: Response time for service calls.

1. Emergency service calls where system is not responding to staff directed commands through the computer systems shall be within 2 hours to the project site.
2. Emergency service calls where controllers are not reporting shall be within 2 hours to the project site.

3. Normal service calls for device malfunctions shall be within 24 hours during normal working hours to the site.

C. Repair Time: Contractor shall stock parts in sufficient quantities such that repair or replacement shall be guaranteed within 12-hours. Temporary replacements within this time period shall be acceptable, provided temporary replacements do not compromise system functionality, and provided permanent replacement is achieved within 72 hours. Contractor may contact Owner representative for use of Owner supplied spare parts where delay of system repair will have negative impact on system performance.

D. Commencement: The warranty begins at the time of issuance of the statement of "Final Acceptance of the Installation" by the Owner.

E. Transferability: The warranty shall be transferable to any person or persons at the discretion of the Owner.

F. Transmittal: A copy of this Warranty shall be delivered to, and signed for by the Owner's representative whose primary responsibility is the operation and care of these systems. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.

G. Registration: Register Warranty papers for all equipment and software in the name of the Owner. Furnish reproductions of all equipment Warranty papers to the Owner with the Final Submittals.

H. Subcontracting: Warranty service work may not be subcontracted except with specific permission and approval by the Owner.

I. Resolution of Conflicts

1. The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory, stating specific areas of dissatisfaction in writing.

2. If the Contractor or his approved Subcontractor does not resolve such stated areas of dissatisfaction within thirty (30) days, the Owner may appoint any alternative service agency or person to fulfill the terms of the Warranty; the cost of which shall be borne by the Contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system or component which is chronically malfunctioning is brought into compliance with the standards of performance as contained herein and published by the manufacturers of the equipment installed.

End of Section
SECTION 27 62 00  ELECTRONIC ACCESS CONTROL SYSTEM

Part 1 - General

1.01  Scope

A.  Refer to Section 27 00 00 for additional project scope information.

B.  This specification section covers the furnishing and installation of new equipment to expand the existing Electronic Access Control System (EACS) at each campus.

C.  Contractor shall furnish and install access control hardware devices, mounting brackets, power supplies, switches, controls, consoles and other components of the system as shown and specified. Existing access control system to be expanded as necessary to accommodate new devices.

D.  Contractor shall furnish and install access control related software to allow this system expansion. Software includes required license addition for access control readers and electrified portals, workstations and required physical security system Integration.

E.  Furnish and install outlets, junction boxes, conduit, connectors, wiring, and other accessories necessary to complete the system installation. Requirements shall be in accordance with Division 26 00 00, Electrical.

1.02  Precedence

A.  Obtain, read and comply with General Conditions and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable sub-section and directions as contained herein, this section shall govern.

1.03  Related Work

A.  Division 08 - Door Hardware
B.  Division 14 - General Elevator Requirements
C.  Section 27 00 00 – General Technology Requirements
D.  Section 27 05 00 – Communications General Requirements
E.  Section 27 05 23 – Pathways for Technology Systems
F.  Section 27 05 26 – Grounding and Bonding for Technology Systems
G.  Section 27 11 00 – Communications Equipment Rooms
H.  Section 27 15 00 – Communications Horizontal Cabling
I.  Section 27 16 00 – Communications Connecting Cords
J.  Section 27 18 00 – Communications Labeling and Identification
K.  Section 27 51 00 – Distributed Communications Systems
L.  Section 27 60 00 – Physical Security General Requirements
Part 1 - Definitions

M. Section 27 64 00 – Video Surveillance System

N. Section 27 66 00 – Intrusion Detection System

1.04 Definitions

A. Refer to Section 27 00 00 for additional definitions.

1.05 Reference Standards and Codes

A. Refer to Section 27 00 00 for additional requirements.

1.06 Qualifications

A. Refer to Section 27 00 00 for additional requirements.

1.07 Pre-Construction Submittals

A. The Contractor shall submit the access control hardware layouts which includes the number of controllers, sub-panels and other associated devices per location.

B. The Contractor shall submit full power calculations which includes the anticipated power loads, number and type of power supplies including all power supply boards, number of 120VAC circuits required, battery backup including the quantities of batteries to meet requirements, PoE loads, fire alarm connection requirements, etc.

C. Refer to Section 27 00 00 and 27 62 00 for additional requirements.

1.08 Pre-installation Procedures

A. For existing facilities or retrofit projects, the Contractor shall assign all applicable electronics IP addresses and pre-build out all the enclosures including the interconnects within the enclosure prior to being delivered to the project or installed.

B. Refer to section 27 00 00 for additional requirements.

1.09 Construction Progress Submittals

A. Refer to Section 27 00 00 requirements.

1.10 Closeout Submittals

A. Refer to Section 27 00 00 for additional requirements.

1.11 Programming

A. All final software configuration and programming shall require consultation with the Owner.

Part 2 - Products

2.01 Substitutions

A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.
2.02 Electronic Access Control Hardware

A. Contractor to tie new card readers and door contacts into existing access control system at campus. Additional panels may be required in the new IDF closets at certain campuses. Refer to drawing set for further information.

2.03 Contactless Smart Card Readers

A. Utilize Wiegand communication or OSDP where required or capable.

B. 13.56MHz only readers

1. Credentials:
   a. Operating Frequency: 13.56 MHz (ISO 15693, 14443A & 14443B)
   b. Contactless smart card reader shall implement the following high security 13.56 MHz applications out-of-box.
      i. Secure Identity Object on HID iCLASS SE
   c. Able to read 37-bit card format.
   d. Able to read NFC
   e. Able to read Bluetooth

2. Integrated keypad.

3. OSDP support.

4. Operating voltage range: 5-16 VDC

5. Current draw: 65mA average and 200mA peak @ 12VDC.

6. Color: Black

7. IP 55 exterior rated.

8. With attached pigtail

9. Typical read range for model R15 of 3.6” with card and 1.6” with fob

10. Typical read range for model R40 of 5.2” with card and 2.8” with fob

11. Provide adapter plate to mount on a single-gang mud ring as required.

12. Firmware upgradable via pre-programmed cards.

13. Provide the ability to transmit an alarm signal via an integrated optical tamper switch if an attempt is made to remove the reader.

14. An audio beeper and RGB light bar shall provide various tone and light sequences to signify: access granted, access denied, power up, and diagnostics.

15. Manufacturer:
   a. Card readers shall be HID iCLASS SE R40 for standard applications and HID iCLASS SE R15 for mullion applications.
b. Card readers with integrated Bluetooth and OSDP support shall be HID iCLASS SE R40 for standard applications and HID iCLASS SE R15 for mullion applications.

c. No non HID iCLASS SE substitutions.

d. Provide each card reader with an Altronix LPD

2.04 Surge Protection for Wiegand Communication

A. The Contractor shall provide a surge protector for all exterior card readers not directly attached to a building which would include any pedestal mounted reader, gate reader or any other exposed reader potentially prone to surges.

B. Mount unit outside of the access control/power supply panels. Provide with appropriate mounting and enclosures as required.

C. There shall be a minimum of a 36” shielded cable from the surge protector to the device to allow for adequate clamping time.

D. When protector is mounted in interior, dry or weather sealed enclosure:

1. Nominal voltage rating of 12V AC/DC. Provide correct module per required voltage level if different from 12V.

2. 20,000A surge current rating.

3. Protects 2-pair per module.

4. Accepts up to 10AWG cable

5. Connect directly to ground.

6. UL 497B listed

7. Provide quantity of modules as required for the application.

8. Provide base mounting plate as required for the application.

9. Manufacturer:
   a. Ditek DTK-2MB Mounting Base
   b. (2) Ditek DTK-2MHLP12B Surge Modules
   c. Or approved equal

2.05 Surge Protection for Low Voltage AC/DC power

A. The Contractor shall provide a surge protector for all exterior devices being supplied by low voltage power. This does not include devices directly connected to a building where the risks of surges are negligible.

B. There shall be a minimum of a 36” shielded cable from the surge protector to the device to allow for adequate clamping time.

C. When protector is mounted in interior, dry or weather sealed enclosure:

1. Nominal voltage rating of 24V AC/DC. Provide correct module per required voltage level if different from 24V.
2.06 Surge Protection for 120 VAC power

A. The Contractor shall provide a surge protector for all 120VAC supplied panels and enclosure when there is a critical risk of surges. This does not include interior panels which only serve interior devices or devices connected directly to a building where the risks of surges are negligible.

B. There shall be a minimum of a 36" of cable from the surge protector to the load to allow for adequate clamping time.

C. When the protector is mount in an interior or exterior location:

1. Nominal voltage rating of 120VAC, single-phase, 20A continuous load.
2. Series connected.
3. 54,000 A surge current rating.
4. 35db of EMI/RFI filtering.
5. UL 1449 Type 2 SPD listed
6. UL 1289 EMI/RFI Noise Filtering listed.
7. LED indicator.
8. Form C dry contacts for monitoring.
9. Include with NEMA 4X enclosure.
10. Maintain a minimum of 3’ of cable from the surge protector to the load.
11. Manufacturer:
   a. Ditek DTK-TSS4D
   b. Or approved equal

2. 20,000A surge current rating.
3. Protects 2-pair per module.
4. Accepts up to 10AWG cable
5. Connect directly to ground.
6. UL 497B listed
7. Provide quantity of modules as required for the application.
8. Provide base mounting plate as required for the application.
9. Manufacturer:
   a. Ditek DTK-2MB Mounting Base
   b. Ditek DTK-2MHLP24B Surge Module
   c. Or approved equal
2.07 Power Supplies and Access Control Enclosures

A. Provide a power supply/chargers and sub-assemblies to power various access controllerboards, locking hardware and other access control or security system components. The Contractor shall select the appropriate enclosure, power supply and sub-assemblies for each application. The Contractor shall include network monitoring modules for all power supplies.

B. Enclosures

1. Shall be capable of accommodating power supplies, sub-assemblies and other manufactures access control controller boards when required.
2. Wall mountable.
3. Include a cam-lock and tamper switch.
4. Trove 2 enclosures when housing access control electronics.
5. eFlow or Maximal enclosures when only power supply components will be within the enclosure.

C. Power Supplies

1. 115 VAC input
2. 12VDC or 24VDC selectable outputs at:
   a. 4 amp continuous power @ 12VDC or 24VDC.
   b. 6 amp continuous power @ 12VDC or 24VDC.
   c. 10 amp continuous power @ 24VDC.
3. High capacity battery charging circuit.
   a. Provide adequate battery backup as required by Authority Having Jurisdiction (AHJ) with a minimum of 8-hours.
4. Form “C” supervision contacts for AC Low, AC Fail, and battery presence.
5. Supervised Fire Disconnect.
6. Low power Disconnect.
7. Class 2 aux. output.
8. UL 294 listed sub-assembly for access control.

D. Sub-Assemblies

1. The Contractor shall provide all sub-assemblies to meet the project requirements
2. Access Control Module
   a. Independently controlled fused protected outputs:
      i. Fail-Safe and/or Fail-Secure power outputs.
      ii. Dry form “C” 5 amp rated relay outputs (fused).
      iii. Any combination of the above
3. Access Control System trigger inputs:
   a. Normally open (NO) inputs.
   b. Open collector sink inputs.
   c. Any combination of the above.

4. Fire Alarm Disconnect:
   a. Individually selectable for any or all outputs.
   b. Latching or non-latch input FACP disconnect.
   c. Normally open (NO), normally closed (NC) dry contact or polarity reversal from FACP
      signaling circuit trigger input.
   d. LED indicates that the Fire Alarm Disconnect has been activated.
   e. Form “C” relay output for auxiliary reporting.

5. Multi-Output Power Distribution Module
   a. Single input distributed over eight (8) outputs.
   b. Fused protected outputs.
   c. Output terminals shall accommodate up to 12AWG wires.

6. Multi-Output Power Distribution Module with Dual Inputs
   a. Two (2) inputs distributed over eight (8) outputs.
   b. Outputs shall be configurable by input.
   c. Fused protected outputs.
   d. Output terminals shall accommodate up to 12AWG wires.

7. Network Communication Modules
   a. Power Supply Network Interface
      i. Interface for up to two (2) eFlow power supply/chargers.
      ii. Two (2) Network controlled From “C” relays.
      iii. Event timers.
   b. Network Power Distribution Module
      i. Two (2) inputs distributed over eight (8) outputs.
      ii. Outputs shall be configurable by input.
      iii. Fused protected outputs.
      iv. Emergency disconnect interface by output.
      v. Selectable battery back-up by output.
      vi. Output terminals shall accommodate up to 12AWG wires.
   c. Common monitoring features
i. Network interface via LAN/WAN.

ii. Centralized dashboard for monitoring all power supplies. Provide appropriate hardware/software required.

iii. Remote reporting of status via email and/or SNMP trap messaging.

iv. AC, low battery and battery presence monitoring.

v. Alert messages of System Service required.

vi. System log.

vii. On demand determination of system status.

viii. Reset of individual outputs as required for remote diagnostics.

ix. Monitor enclosure temperature.

x. Static or DHCP IP address configuration.

xi. SSL Secure Sockets Layer encryption.

8. Voltage Regulator

a. The Contractor shall provide a voltage regulator to provide constant 5VDC or 12VDC outputs for access control boards, modules or other applicable components as well as a voltage regulator for door hardwiring or controllers requiring 12VDC.

b. 24vdc Input.

c. Selectable 5 or 12VDC output.

d. Output rating of 6amp max.

e. Stackable with both Networkable and dual input power distribution modules for space savings.

9. Power supplies and sub-assemblies shall be manufactured by Altronix or approved equal:

a. eflow4NB - 4amp 12vdc/24vdc power supply (UL listed Sub-assembly).

b. eFlow6NB - 6amp 12vdc/24vdc power supply (UL listed Sub-assembly).

c. eFlow104NB - 10amp 24vdc power supply (UL listed Sub-assembly).

d. ACM8 - Eight (8) output, fused Access Control Module (UL listed Sub-assembly).

e. ACMS8 – Dual input, eight (8) output, fused Access Control Module (UL listed Sub-assembly).

f. Linq2 - Network Communication Module (UL listed Sub-assembly).

g. Linq8PD - Dual input, eight (8) output, fused Network Communication Module (UL listed Sub-assembly).

h. PDS8 - Dual input, eight (8) output, fused power distribution module (UL listed Sub-assembly).

i. VR6 - Voltage Regulator (UL listed Sub-assembly).
2.08 High Current Power Supplies for Electric Latch Retraction

A. 115 VAC input, 6.3A.

B. (2) 20VDC to 26.4VDC individually controlled lock outputs.

C. Provides up to 15 amps for up to 300ms for high inrush applications and up to .75 amps continuous holding current.

D. Auxiliary 12VDC always on output up to .75A.

E. High capacity battery charging circuit.

   1. Provide adequate battery backup as required by Authority Having Jurisdiction (AHJ) or a minimum of 1-hour when power supply is not connected to a UPS circuit.

F. (2) Normally Open trigger inputs.

G. Normally closed FACP trigger input.

H. Trouble relay output indicating low DC output voltage.

I. UL 294 listed sub-assembly for access control.

J. Include with lockable enclosure.

K. Provide with appropriate gauge wire to allow for remote mounting according to manufacturer’s recommendations.

L. Manufacturer:

   1. Altronix Strikelt1

   2. Or approved equal

2.09 Wiegand Extenders

A. The Contractor shall provide an extender for any card reader location within an elevator. Coordinate connection to the travel cable, travel cable requirements and installation within the elevator cab and equipment room with the elevator contractor.

B. Additionally, the Contractor shall provide an extender for any card reader located more than 500’ from the access control panel.

C. When not connecting to an elevator travel cable provide 18-AWG, shielded 2-conductor cable between near and far end units utilizing Belden 8760 or equal.

D. Extends up to 4,000 feet on 22 awg cable and 10,000 on 18 awg cable.

E. Devices shall be fully supervised.

F. Rugged aluminum housing.

G. Operating temp rating from -40 F to +176 F.

H. Provide with near end and far end units.
I. Provide with power supplies as necessary. Access control power supply may be utilized so long as the correct voltage is utilized.

J. Manufacturer:
   1. Cypress SPX-1300
   2. Or approved equal

2.10 Cables

A. Provide cabling per manufacturer’s recommendations and code requirements for riser rated, plenum, and non-plenum cable types.

B. UTP data cabling required will be provided, installed, terminated and tested by the Division 27 structured cabling Contractor.

C. UTP patch cables will be provided and installed by the Owner in the IDF and provided by Owner and installed by Contractor at the door. The EACS Contractor shall provide the Owner a list of patch cable lengths at the door side.

D. Cables for electronic access controlled doors shall be a composite bundled cable and include the following cables and conductor counts:
   3. Lock power – 4 conductor, 18 awg unshielded.
   4. Door contact – 2 conductor, 22 awg unshielded
   5. Request to exit and/or latch detection/spare – 4 conductor, 22 awg unshielded

E. Manufacturer:
   1. Belden (OSDP) #658AFJ
   2. Belden (Wiegand) #658AFS
   3. General Cable (Wiegand) #4EPL1S
   4. Superior Essex (Wiegand) #AC-A1x-68
   5. Or approved equal

F. Cables for RS-485 shall be 24-AWG, 2-pair with 100% coverage aluminum foil shield and 90% coverage outer tinned copper braid shield.
   1. Manufacturer:
      a. Belden #9843
      b. Or approved equal

G. Cables for PoE locks shall be installed by the Division 27 cabling contractor. Horizontal cable shall be terminated above the door within a j-box to provide a disconnect point for the patch cable to the PoE hinge.
2.11 Door Contacts/Door Position Switches (DC)

A. The Security Contractor shall be responsible for the connection of all door position devices to the access control system. Door position devices shall be integral to the door hardware whenever possible. The Contractor shall refer to the door hardware schedule and coordinate with the door hardware Contractor on locations and requirements.

B. Sealed and potted magnetic reed switch in contact housing.

C. Provide DPDT contacts at all locations – every door contact shall connect to both the intrusion system and the access control system.

D. Provide color that matches door as close as possible.

E. Provide recessed switch whenever possible.

F. Armored whip for surface mount contacts.

G. Provide UTC Interlogix 1078 Series for recessed applications.
   1. Or approved equal.

H. Provide UTC Interlogix 2500 Series for surface mount applications.
   1. Or approved equal.

I. Provide UTC Interlogix 2200 Series for overhead door applications.
   1. Or approved equal.

2.12 Request to Exit (REX) Devices

A. The Security Contractor shall be responsible for the connection of all request to exit devices integral to the door, motion based or other to the access control system. Request to Exit devices shall be integral to the door hardware whenever possible. The Contractor shall refer to the door hardware schedule and coordinate with the door hardware Contractor on locations and requirements. Motion based Request to Exit devices shall only be used when not available in the door hardware.

B. The motion based REX shall be a dual technology device with Passive Infrared (PIR) and Range-Controlled Radar (RCR) motion detector.

C. Reduces false alarms by sensing both heat and physical motion.

D. Independent adjustable beam pattern and radar depth.

E. Provide with mounting plate or wall mounting plate to mount over a single-gang backbox when required.

F. Provide color that matches door as close as possible.

G. DPDT output.

H. DC Power draw: 28mA max @ 12 VDC, 17mA max @ 24 VDC.
I. AC Power draw: 38mA max @ 12 VAC, 29mA max @ 24 VAC.

J. Dimensions: 1.76"H x 7.395"W x 1.85"D.

K. Utilize contact closure REX hardware built into the handle or crashbar whenever possible.

L. Provide UTC Interlogix RCR-REX.
   1. Or approved dual technology equal.

2.13 Electrified Hardware (EH)

A. The Security Contractor shall be responsible for the connection of all electrified hardware to the access control system. This shall include providing centralized power supplies located next to or integral to the access control panels. The Contractor shall coordinate with the door hardware specifications and schedules for additional information.

2.14 Door Loops (Power Transfer Loops)

A. Provide new power transfer loops at the top of the doors for retrofit applications.

B. Provide all necessary materials and labor to connect existing electrified panic hardware and new access control system where appropriate.

C. Power transfer loop shall be armored stainless steel door loop with metal end caps.

D. Minimum interior diameter of 3/8" and exterior diameter of 1/2".

E. Field verify the lengths required for each door.

F. Provide RCI #9508.
   1. Or approved equal.

2.15 Badges, Fobs and Credentials

1. Confirm with the district if further credentials will be required for use with the existing system.

2.16 Access Control/Video Surveillance/Intrusion Detection Integration

A. The electronic access control system shall be integrated with the video surveillance system and intrusion detection system.

   1. The access control/intrusion detection interface shall be via an RS-232 or Ethernet interface. Contact closure integration shall only be utilized if the system is existing and cannot be upgraded to support RS-232 or Ethernet. The Contractor shall supply all necessary expansion boards if contact closure integration will be required.

   2. The access control/video surveillance integration shall be via a native IP interface.

   3. The video surveillance/intrusion detection interface shall be via an RS-232 or Ethernet interface. Contact closure integration shall only be utilized if the system is existing and cannot be upgraded to support RS-232 or Ethernet. The Contractor shall supply all necessary expansion boards if contact closure integration will be required.

B. The Contractor shall provide any and all licensing to integrate the systems together including any additional items to be added to the yearly maintenance agreement.
C. The following minimum features shall be included in the integration; the following list is not all inclusive or exhaustive. The integration shall be a turnkey solution:

1. Call up live and/or recorded video from an alarm or event.
2. Graphical maps showing camera icons.
3. “Mouse over” camera viewing through the DVR/NVR browser and graphical maps.
4. Playback controls for recorded video.
5. Camera names brought in from the VMS.
6. PTZ camera mouse control.
7. Database entries for intrusion arm/disarm events on individual keypads.
8. Database entries for intrusion alarm events.
9. Graphical map symbols for intrusion keypads tied to camera views.
10. Intrusion devices or zones tied to camera views.
11. Alarm pop-ups and events shall include instructions and a sequence of operation to deal with events on the Intrusion Detection System, Video Management System and Electronic Access Control System.
12. Time syncing via common NTP server.

D. The Contractor shall set up a meeting between the Owner, Consultant and manufacturer to determine the exact functionality of the integration before the integration starts.

Part 3 - Execution

3.01 Testing

A. Refer to Section 27 00 00 for additional requirements.

B. Prior to energizing or testing the system, ensure the following:

1. All products are installed in a proper and safe manner per the manufacturer’s instructions.
2. Dust, debris, solder, splatter, etc., is removed.
3. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
4. All products are neat, clean, and unmarred, and parts are securely attached.

C. Contractor shall ensure that each device in the security system is functioning normally and in such a manner as to meet the functional and performance requirements in this specification.

3.02 Warranty

A. Refer to Section 27 00 00 for additional requirements.

3.03 Installation Practices

A. All services provided shall be professional and conform to the highest standards for industry practices. The Owner reserves the right to halt any installation due to poor workmanship. All
work shall be defect free, and the installer shall replace, at their expense, any work found to be defective.

B. The Owner reserves the right to halt any installation due to failure of Contractor to observe installation-free periods due to instructional or administrative requirements. To the maximum extent possible, the Owner will provide advance notice of such periods.

C. Contractor is responsible for providing a complete and system.

D. All manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by the manufacturers, or as indicated in their published literature, unless specifically noted herein to the contrary.

E. Contractor shall follow these standards and approved submittals for locations of power supplies. The Owner intends to limit the number and location of power supplies to facilitate more effective long-term support and maintenance of the system.

3.04 Coordination

A. Contractor shall provide up to 8 hours (up to four, 2-hour sessions) of scheduled and dedicated coordination time to assist Owner with sequence of operation, rule creation and coordination as requested by Owner or Consultant.

3.05 Aesthetics

A. All cables and equipment terminating at panels frames shall be vertically straight, with no cables crossing each other, from twelve inches inside the ceiling area to the termination block.

B. All cable bundles shall be combed and bundled to accommodate individual termination block rows and panels.

C. For any given telecom room, a horizontal and vertical alignment for all mounting hardware will be maintained to provide a symmetrical and uniform appearance to the distribution frame.

D. All surface-mounted devices shall be firmly secured level and plumb

E. All rack mount equipment shall be securely installed.

3.06 Hardware Layout

A. Hardware positioning and layout shall be reviewed and approved by the Owner prior to construction. The review does not exempt Contractor from meeting any of the requirements stated in this document.

3.07 Server Installation Practices

A. Verify that the manufacturer approved server hardware, OS meets the Owner’s IT standards prior to ordering.

B. Coordinate server power, cooling, and mounting requirements with Owner prior to installation.

C. Coordinate virus scan/security software requirements with Owner and manufacturer prior to installation.
3.08 Device Cabling/Wiring Installation Practices

A. All external wire and cables shall be supported at least every five feet from the structure or as required to maintain not more than 12" cable sag between supports and without over tensioning the cables. Provide J-hooks as needed where cable tray or raceway is not available.

B. This Contractor shall coordinate installation with Division 27 cabling Contractor to ensure there is at least 2-inches of physical separation between security cabling and voice/data cabling throughout cable path. Voice/data cabling Contractor has first claim to cable tray.

C. All cables, regardless of length, shall be labeled within 18" of both ends with an identifier that is keyed to the door, room, or corridor number as identified.

D. All cables shall have 6-foot service loops neatly coiled in the equipment room. During initial cable rough-in, this Contractor shall have sufficient slack to route anywhere within the equipment room.

E. Cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame. Cables shall be dressed in a neat and orderly fashion. Any cabling or equipment installation that is deemed unacceptable by the Owner or Consultant shall be replaced or corrected by the Contractor at no additional cost. Plastic zip ties are not allowed.

F. All cables are to run at right angles to the structure, placed above the ceiling in halls or corridors.

G. Cables shall not run above red iron joist.

H. Contractor shall make every effort to conceal wiring and other apparatus into walls, floors, and ceilings, assuming code and good engineering practice allows and suggests.

I. Ties and straps shall be installed snugly without deforming cable insulation. Ties shall be spaced at uneven intervals not to exceed four feet. No sharp burrs shall remain where excess length of the cable tie has been cut.

J. Contractor shall notify Owner immediately if obstruction or hazard is discovered in a pathway provided by others.

K. Cable shall be stored and handled to assure that it is not stretched, kinked, crushed, or abraded in any way. Bend radiuses shall meet manufacturer specifications and/or recommendations. Cable shall not be installed in ambient temperatures or moisture conditions above or below the manufacturer’s rating.

L. No splices shall be installed in any cable.

3.09 Cable Termination

A. Termination hardware (blocks and patch panels) positioning and layout shall be reviewed and approved by the Owner prior to construction. The review does not exempt Contractor from meeting any of the requirements stated in this document.

3.10 Physical Security Systems and Intercom Integration

A. The electronic access control system shall be integrated with the video surveillance system and intrusion detection system.
1. The access control/intrusion detection interface shall be via an Ethernet interface. Contact closure integration shall only be utilized if the system is existing and cannot be upgraded to Ethernet. The Contractor shall supply all necessary expansion boards if contact closure integration will be required.

2. The access control/video surveillance integration shall be via a native IP interface.

3. The video surveillance/intrusion detection interface shall be via an Ethernet interface.

B. The Contractor shall provide any and all licensing to integrate the systems together including any additional items to be added to the yearly maintenance agreement.

C. The following minimum features shall be included in the integration; the following list is not all inclusive or exhaustive. The integration shall be a turnkey solution:

1. Call up live and/or recorded video from an alarm or event.
2. Graphical maps showing camera icons.
3. “Mouse over” camera viewing through the DVR/NVR browser and graphical maps.
4. Playback controls for recorded video.
5. Camera names brought in from the VMS.
6. PTZ camera mouse control.
7. Database entries for intrusion arm/disarm events on individual keypads.
8. Database entries for intrusion alarm events.
9. Graphical map symbols for intrusion keypads tied to camera views.
10. Intrusion devices or zones tied to camera views.
11. Alarm pop-ups and events shall include instructions and a sequence of operation to deal with events on the Intrusion Detection System, Video Management System and Electronic Access Control System.
12. Intercom pop-ups when call button is pressed with the ability to unlock the door.
13. Time syncing via common NTP server.

D. The Contractor shall set up a meeting between the Owner, Consultant and manufacturer to determine the exact functionality of the integration before the integration starts.

3.11 Elevator Interface

A. The Contractor shall furnish and install an elevator interface box outside of the elevator equipment room.

1. The Contractor shall provide an elevator security junction box located outside of the Elevator Machine Room, for interface of security devices to be located within the elevator cab(s). This requirement complies with ANSI A17.1 code which prevents work within the Elevator Machine Room, other than specific elevator work.

2. Security J-box shall include a keyed lockable door. Additionally, security J-box shall have proper terminal strips suitable for terminating all cables and mounting electronics within the J-box.
3. The Electrical Contractor shall provide 120VAC power to this enclosure as required to power the electronics.

4. The Contractor shall provide any data cables to this enclosure as required.

5. Electronics for video surveillance such as coax to IP converters may be placed within this enclosure.

6. Coordinate exact location of elevator security junction box with the Elevator Contractor, Architect, and Consultant, prior to installation.

7. Provide all cabling as required between the security system and elevator security J-box for all elevator interfaces.

8. Provide all required interface points for connecting to elevator relays and travel cables.

9. Cables entering the elevator security J-box and elevator equipment room shall be appropriately labeled by the Contractor, so that the Elevator Contractor can connect the appropriate wires to the elevator controllers. Wires should be individually labeled to separate them from other elevator functions and to assist the Elevator Contractor in making proper connection points.

10. The Contractor shall assume all floors and all doors shall have the ability to be controlled and cable the system appropriately.

11. The Contractor shall coordinate with the Elevator Contractor to ensure the appropriate cable is located within the elevator travel cable.

12. Software level integration via IP is acceptable.

B. Provide for Access Control System Interface and Programming, as follows:

1. Elevator Alarm Button shall be interfaced to alarm input on the access control interface panel, in addition to interface with the Elevator Status panels.

2. When elevator is operating on “Override” modes (i.e. either from Elevator Control Room or in “Fireman’s Service Override Mode”), all card reader and other controls shall be overridden.

3.12 ADA Power Assist Door Operator Interface

A. Certain electric locking mechanisms with card access shall be connected (hardwired) to the ADA Power Assist Door Operator pushbutton. In this scenario, card reader shall be interfaced to the ADA Door Operator pushbutton to approve activation of door motor based on card authorization or pre-programmed security schedule.

B. Door motor shall not be energized until authorized by the security system to prevent operation and eventual burn-out of the motor from hitting the button with the security system activated.

C. Contractor shall provide all necessary hardware, interfaces, and system programming.

3.13 Fire Alarm Interface

A. Certain electric locking mechanisms shall be connected (hardwired) to the building fire alarm system for fail safe release upon any fire alarm. A single low voltage/low current normally closed dry contact from the fire alarm system shall be provided by others in each room with Security Control Panels. This contact shall open on any fire alarm condition.
B. The Contractor shall provide all additional UL listed failsafe relays and power supplies as necessary to interface to this contact and unlock all of these doors.

C. The Contractor shall verify fail safe and fail secure locking requirements with the Architect, door hardware contractor/provider and the AHJ. Refer to fire alarm contractor shop drawing for fire alarm interface requirements.

3.14 Fire Stopping

A. Fire stopping of openings between floors, fire-rated walls, and smoke-rated walls, created by others for This Contractor to pass cable through, shall be the responsibility of the This Contractor. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work.

B. Any openings created by or for This Contractor and left unused shall be sealed up by This Contractor.

C. This Contractor shall be responsible for creating a waterproof seal in and around any openings that This Contractor creates from the structure to the outside environment.

3.15 System Inspection

A. Contractor shall coordinate with project representative for inspection after Contractor has completed testing of entire system.

B. Contractor shall have trained Contractor representative and testing equipment on site during inspection to assist with spot verification of tests.

C. System inspection shall include Consultant as well as Owner’s Safety and Security Department.

3.16 Labeling

A. Contractor shall neatly label all security devices and cabling at both ends. All labels shall be on Project as-built drawings.

3.17 Documentation

A. Upon completion of the installation, Contractor shall provide full documentation sets to the Consultant for approval as described in section 27 60 00. All documentation shall become the property of the Owner.

B. Documentation shall include the additional specific items detailed in the subsections below:

1. Contractor shall provide hard copy and electronic forms of the final test results.

2. Contractor shall provide a document including the following:
   a. Door label/identifier
   b. Location of each drop by orientation/permanent landmark in the room
   c. Contractor shall provide accurate as-built Construction Drawings. The drawings are to include cable routes and device locations.
3.18 Pre-Check out
   A. The Contractor shall demonstrate the following to Owner during system demonstration.
      1. The card readers are fully installed and functional.

3.19 Final Acceptance
   A. In addition to closeout requirements in section 27 60 00, This Contractor shall demonstrate
      the following before final approval.
      1. Owner training is complete.
      2. Punch list items are complete.
      3. As-built documentation is complete and submitted to Owner/Consultant.

3.20 Final Procedures
   A. Perform final procedures in accordance with section 27 60 00.

End of Section
SECTION 27 64 00 VIDEO SURVEILLANCE SYSTEM

Part 1 - General

1.01 Scope

A. Refer to Section 27 00 00 for additional project scope information.

B. The Contractor shall provide new CCTV devices as shown on plans that will tie into the existing CCTV system on campus. Existing system to be expanded as necessary to accommodate new devices. Not all sections will be applicable. Refer to drawings for further information.

C. The Category 6 cabling to each camera shall be provided by the structured cabling Contractor.

D. System installation shall include, but not be limited to, installation, programming, and configuration of system components as well as all associated software upgrades, patches, and maintenance for the first year.

E. Contractor is responsible for meeting with Owner’s representative at time of camera installation to verify exact placement and view of each camera to ensure coverage area is as intended.

1.02 Precedence

A. Obtain, read and comply with General Conditions and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable sub-section and directions as contained herein, this section shall govern.

1.03 Related Work

A. Division 14 - General Elevator Requirements

B. Section 27 00 00 – General Technology Requirements

C. Section 27 05 00 – Communications General Requirements

D. Section 27 05 23 – Pathways for Technology Systems

E. Section 27 05 26 – Grounding and Bonding for Technology Systems

F. Section 27 11 00 – Communications Equipment Rooms

G. Section 27 15 00 – Communications Horizontal Cabling

H. Section 27 16 00 – Communications Connecting Cords

I. Section 27 18 00 – Communications Labeling and Identification

J. Section 27 51 00 – Distributed Communications Systems

K. Section 27 60 00 – Physical Security General Requirements

L. Section 27 62 00 – Electronic Access Control System

M. Section 27 66 00 – Intrusion Detection System
1.04 Definitions
   A. Refer to Section 27 00 00 for additional definitions.

1.05 Reference Standards and Codes
   A. Refer to Section 27 00 00 for additional requirements.

1.06 Qualifications
   A. Refer to Section 27 00 00 for additional requirements.

1.07 Pre-Construction Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.08 Construction Progress Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.09 Closeout Submittals
   A. Refer to Section 27 00 00 for additional requirements.

1.10 General Summary
   A. The Category 6 cabling to each camera shall be provided by the structured cabling Contractor. Patch cords for the IP cameras to the network switches shall be furnished by this Contractor and installed by the Owner with participation by this Contractor. Patch cords from the IP Camera to the data jack shall be furnished by this Contractor and installed by this Contractor.

   B. System installation shall include, but not be limited to, installation, programming, and configuration of system components as well as all associated software upgrades, patches, and maintenance for the first year.

   C. Contractor is responsible for meeting with Owner’s representative at time of camera installation to verify exact placement and view of each camera to ensure coverage area is as intended.

1.11 Drawing Sheets
   A. All cameras are designated with a C symbol on the project drawings. PTZ (Pan Tilt Zoom) cameras are designated with PTZ text next to the C symbol.

1.12 Mounting and Installation
   A. Contractor shall provide the appropriate mounting hardware for all ceiling types and wall types where cameras shall be located. Plastic anchors are not allowed.

   B. Wall mounted 180/360 degree or multi-sensor cameras shall be mounted horizontally on a wall arm, gooseneck, parapet, pendant or other similar method.

   C. Exterior cameras shall be mounted on a wall arm/gooseneck.

   D. Cameras mounted in droptile shall have a tile support bridge with a steel support cable connected to structure to prevent tile sagging, theft and vandalism. Utilizing toggle bolts or other screw in anchors is not allowed.
1.13 Code and Standard Requirements

A. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association and any other codes as required by the AHJ.

B. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

C. Cameras shall meet the following standards:
   1. MPEG-4:
      a. ISO/IEC 14496-10 AVC (H.264)
   2. Networking:
      a. IEEE 802.3af (Power over Ethernet)
   3. Network Video:
      a. ONVIF Profile S or better

Part 2 - Products

2.01 Substitutions

A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 VMS Video Storage

A. Contractor shall coordinate with District Technology Group to ensure that existing VMS is capable of meeting the following requirements with the cameras being added within project scope. Contractor shall coordinate with the District to provide additional storage for existing VMS as necessary.

B. Provide a minimum of thirty-five (35) days of storage calculated at the following resolution and rates. Provide all hardware, software and configuration needed to accomplish this.

C. Record stream using Unicast RTP/TCP

D. Pre and post record buffer of 5 seconds.

E. Provide an additional ~10% storage for additional space.

   1. Interior Cameras:
      a. 15 fps
      b. 1 keyframe (I-Frame) per second
      c. Max resolution
      d. 100% recording with motion enabled for meta data.
      e. VBR or framerate priority with cap appropriate to resolution and quality
f. H.264 Main Profile compression

g. Smart codec enabled at a medium setting with a dynamic GoP of up to 4 seconds.

h. No data rate cap when smart codecs are enabled.

i. Audio encoding (for cameras with microphones connected or built into them).

2. Exterior Cameras:

   a. 15 fps

   b. 1 keyframe (I-Frame) per second

   c. Max resolution

   d. 100% recording with motion enabled for meta data.

   e. VBR or framerate priority with cap appropriate to resolution and quality

   f. H.264 Main Profile compression

   g. Smart codec enabled at a medium setting with a dynamic GoP of up to 4 seconds.

   h. No data rate cap when smart codecs are enabled.

2.03 VMS Client Workstations

   A. Workstations shall be Owner-Furnished. Contractor shall provide workstation requirements to Owner for them to order, and Contractor shall install and configure VMS software on the workstations on site. Plan for a minimum of two workstations.

2.04 Cameras and Devices

   A. General:

      1. All cameras and devices shall be time synced to the Owner’s NTP server. Coordinate with the Owner to acquire the appropriate NTP address to use.

      2. The contractor shall coordinate with the owner for IP addressing, network configuration, QoS and multicast network configuration.

      3. The Contractor shall enable QoS on all cameras and intercoms for the video stream, audio stream, event/alarm data, management and metadata at the Owners request.

      4. The system shall be configured for multicast. All cameras shall have a multicast Time To Live (TTL) setting of at least 64.

      5. The Contractor shall select the appropriate mounting hardware for the situation.

      6. All cameras shall be equipped with remote autofocus or autoback focus with the exception of fixed lens 180/360 degree cameras and encoded analog cameras.

      7. Multi-sensor 180 and 360 cameras shall have each sensor optimally calibrated independently to the conditions.

      8. All cameras shall be vandal proof and appropriate for the environment it is being installed in.

      9. All cameras shall have the latest VMS recommended firmware installed and all cameras of the same model shall have matching firmware versions. The Contractor shall provide all
necessary firmware upgrades to keep the Owner on the latest version throughout the duration of the project. At the completion of the project the Owner shall have the option to receive a final firmware update the latest version before the project is paid in full.

10. The contractor shall coordinate with the owner for IP addressing, network configuration and multicast network configuration.

11. All cameras regardless of manufacturer/model shall have a consistent user name and non-standard password set. This shall be documented and provided to the owner and consultant prior to inspections.

12. Cameras and devices shall not be an OEM or “white label” product. The camera or device shall be manufactured by the named manufacturer.

13. The cameras and devices firmware shall be developed and manufactured by the stated manufacturer and shall not be developed, written or OEM by a 3rd party.

14. The camera requirements below represent general performance criteria. Approved equals will have slight differences in specifications. The Owner and Consultant have complete discretion to reject approved equals that stray too far from the minimum requirements.

B. Camera Requirements

1. All cameras shall be Contractor-Furnished, Contractor-Installed.

2. Contractor shall provide camera licenses as necessary to bring all cameras into the VMS.

3. Contractor shall confirm with Owner which camera model is required to be installed at each location. The floor plans show a few different general types (standard lens, 180-degree, 270-degree corner mount, 360-degree, etc.), but do not indicate exactly what model is to be used at each location.

4. The Contractor shall provide all camera mounts and accessories necessary to install the cameras. Camera mounts shall be coordinated between the Contractor and the Owner to ensure the mounts match the type of camera being provided and the installation conditions. Refer to general camera mount requirements below.

C. Approved Manufacturers:

1. Standard Interior – Axis P3228-LV

2. Standard Exterior – Axis P3328 LVE Vandal Resistant

3. Fish Eye – Axis P3058 PLVE

4. Exterior Panoramic 180/360 – Axis P3717-PLE

5. Contractor shall confirm current camera models with Owner prior to ordering. Available models are likely to change by the time the building is completed. Discontinued models or models that will be phased out shortly shall not be acceptable, regardless of the part numbers listed in this specification.

2.05 Camera Mounts

A. Ceiling mounted interior cameras will not be supported directly on the ceiling tile and will have a T-bar or other type system that will keep the camera weight supported on the grid and not the tile.

1. Acceptable mount manufacturer shall match the camera make and model.
2. In addition to grid supported mounts, all new ceiling cameras will be supported with additional security wire that will prevent the camera from falling down should the ceiling grid be removed. This wire can be attached to the camera directly only by following the manufacturer’s recommendations.
   a. Do not install the support wire onto any other cable pathway, dedicated ceiling grid wire or sprinkler system.

3. New ceiling mounted cameras at all other locations will be trimmed out with white colored mounts and trim kits. This is required for all lay in ceiling locations.

B. Interior wall mounted camera locations (if applicable) will be mounted directly on the provided back box. Verify all locations on site.

1. Interior wall mounted camera locations will be installed with white colored flush mounts and trim out kits.

2. Coordinate all final locations and heights with the District, the general contractor and the electrical contractor prior to final rough in locations. Failure to coordinate with these parties may result in the camera location being changed at the contractor’s cost. The locations of the cameras will be, in the opinion of the installing contractor, at the height to provide the optimum image needed by the client.

C. All exterior building fixed camera mounts will be colored white. Cameras will be surface mounted at all exterior locations.

1. Mount exterior fixed cameras to the exterior surface of the wall of the building at the locations shown. Use the appropriate anchors to secure the cameras to the building exterior. Do not use plastic anchors to support the cameras.

2. Backboxes and conduit sleeves will be provided by the electrical contractor. Patch cables for the cameras shall be provided by the cabling contractor.

3. Coordinate all final locations and heights with the District, the general contractor and the electrical contractor prior to final rough in locations. Failure to coordinate with these parties may result in the camera location being changed at the contractor’s cost. The locations of the cameras will be, in the opinion of the installing contractor, at the height that provides the optimum image needed by the client.

2.06 Camera Management Tools

A. The Contractor shall setup on an appropriate server the manufacturer’s camera management tools utilized to manage the settings, firmware and status of all installed cameras. The Contractor shall train the Owner on the use of this software.

2.07 Ethernet with PoE Over 75 Ohm Coaxial Cable

A. The contractor shall provide an Ethernet over coaxial cable converter for each camera mounted within an elevator and other locations as required or noted.

B. Each camera shall receive its own dedicated transmitter and receiver unit. Splitting multiple cameras through a single Tx/Rx pair is not allowed.

C. The Contractor shall coordinate with the Elevator Contractor for installation.

D. Shall support multi-cast networks.

E. Provide full duplex 10/100Base-T.
F. Shall support IEEE 802.3af (PoE) and IEEE 802.3at (PoE+) on input and output.

G. Can support 802.3at at 20 watts at a minimum of 1,000 feet of 20awg RG-59.

H. BS EN 50121-4 compliant.

I. Operating temperature range of -40 to +158 degrees F.

J. Provide with optional power supply when PoE switch is not available.

K. Provide with wall mount or rack mount bracket as required.

L. Manufacturer:
   1. Veracity Highwire Longstar
      a. Provide with dedicated power supply as or when required.
   2. Or approved equal

2.08 Ethernet with Power over Ethernet (PoE) UTP Surge Suppressor

A. The Contractor shall provide and install a surge protector for all exterior mounted cameras. Cameras that are not attached to the building or reach above the building roof line shall have a surge protector at the camera side and interior termination side.

B. There shall be a minimum of a 36” shielded patch cable from the surge protector to the device to allow for adequate clamping time.

C. When protector is mounted in interior, dry or weather sealed enclosure:
   1. Shielded RJ-45 jacks and ground stud
      a. Connect ground directly to ground bar (TMGB/TGB) or ground.
      b. Do not use shielded cable on the output.
   2. Maximum supported data rate: 10,000Mb/s (10 Gigabit)
   3. Supports IEEE 802.3af (PoE)
   4. Max current rating of 30A per pair.
   5. UL 497B listed
   6. 110 punch down in and 110 punch down out.
      a. 110 punch down in and RJ-45 out may be used when output is connected directly to a switch only when approved in specific situations.
   7. Manufacturer:
      a. Ditek DTK-110C6APOE
      b. Or approved equal

D. When protector is exposed to weather or moisture:
   1. Shielded RJ-45 jacks and ground connection.
a. Connected ground connection directly to ground.
   b. Do not use shielded cable on the output.

2. Outdoor-rated NEMA 4X enclosure

3. Maximum supported data rate: 1,000Mb/s (1 Gigabit)

4. Supports IEEE 802.3af, 802.3at (PoE) and PoE+ up to 144 watts per port.

5. Max current rating of 20,000A per pair.

6. UL 497B listed

7. RG-45 in and RJ-45 out.

8. Provide with appropriate mounting kit.

9. Manufacturer:
   a. Ditek DTK-MRJPOEX
   b. Or approved equal

2.09 Ethernet UTP Surge Suppressor (No PoE)

   A. The Contractor shall provide and install a surge protector for all exterior mounted cameras. Cameras that are not attached to the building or reach above the building roof line shall have a surge protector at the camera side and interior termination side.

   B. There shall be a minimum of a 36” shielded patch cable from the surge protector to the device to allow for adequate clamping time.

   C. When protector is mounted in interior, dry or weather sealed enclosure:

      1. Shielded RJ-45 jacks and ground stud
         a. Connect ground directly to ground bar (TMGB/TGB) or ground.
         b. Do not use shielded cable on the output.

      2. Maximum supported data rate: 10,000Mb/s (10 Gigabit)

      3. Max current rating of 100A per pair.

      4. UL 497B listed

      5. 110 punch down in and 110 punch down out.
         a. 110 punch down in and RJ-45 out may be used when output is connected directly to a switch only when approved in specific situations.

      6. Manufacturer:
         a. Ditek DTK-110C6A
         b. Or approved equal
2.10 Managed Power Supplies

A. The Contractor shall provide and install a power supply for exterior cameras, PTZ Cameras, fiber optic media converters and other devices which require a dedicated power supply capable of outputting 24VAC and 28VAC simultaneously.

B. The Contractor shall connect each device to a 24VAC or 28VAC output according to the voltage drop to stay as close to 24VAC at the end point as possible based on actual field measurements.

C. The power supply shall have network modules capable of controlling each individual output via a web interface. Each power distribution module shall be clearly labeled as a 24VAC output or 28VAC output.

D. The power supply shall be grounded with a 6awg cable.

E. The Contractor shall provide (1) Altronix BC300 enclosure, (2) T2428300 transformers and (2) LinQ8PD networked power distribution modules. Alternate configurations may be submitted for approval.

2.11 Voltage Regulator

A. The Contractor shall provide voltage regulators to convert from, 24 VAC power to 12 VDC power where required.

B. Input: 24 VAC or 24 VDC

C. Output: 12VDC up to 3A continuous load.

D. Manufacturer:
   1. Altronix VR5T
   2. Or approved equal

2.12 Fiber Optic Media Converters

A. The contractor shall provide fiber optic media converters for locations that require fiber optic cable due to distances that exceed copper cable distance limitation or as identified on the drawings. Provide a rack mount chassis when multiple outputs are required.

B. Single port, industrial interior/exterior
   1. 10/100 Ethernet full duplex
   2. Operating temperature of -40 - 167 degrees F
   3. 1300 multimode ST fiber connectors
   4. Link budget of 12.0 dB
   5. DIN Rail mountable, provide with appropriate brackets as required
   6. AC version requires 22-36 VAC. Provide with power supply where required.
   7. Mount in NEMA rated enclosure when installed in the exterior
   8. Manufacturer:
      a. Transition Networks (AC version) M/E-ISW-FX-01AC(ST)
b. Or approved equal

C. Rack mount multi-port, card based headend
   1. 10/100 Ethernet, Class A, full duplex
   2. 1300 multimode ST fiber connectors
   3. Link budget of 11.0 dB
   4. Provide slot quantity as required
   5. 120VAC power connection
   6. Manufacturer:
      a. Slide in module - Transition Networks C2210-1011
      b. Chassis - Transition Networks ION219A series
      c. Or approved equal

2.13 Access Control/Video Surveillance/Intrusion Detection Integration

A. The electronic access control system shall be integrated with the video surveillance system and intrusion detection system.
   1. The access control/intrusion detection interface shall be via an RS-232 or Ethernet interface. Contact closure integration shall only be utilized if the system is existing and cannot be upgraded to support RS-232 or Ethernet. The Contractor shall supply all necessary expansion boards if contact closure integration will be required.
   2. The access control/video surveillance integration shall be via a native IP interface.
   3. The video surveillance/intrusion detection interface shall be via an RS-232 or Ethernet interface. Contact closure integration shall only be utilized if the system is existing and cannot be upgraded to support RS-232 or Ethernet. The Contractor shall supply all necessary expansion boards if contact closure integration will be required.

B. The Contractor shall provide any and all licensing to integrate the systems together including any additional items to be added to the yearly maintenance agreement.

C. The following minimum features shall be included in the integration; the following list is not all inclusive or exhaustive. The integration shall be a turnkey solution:
   1. Call up live and/or recorded video from an alarm or event.
   2. Graphical maps showing camera icons.
   3. “Mouse over” camera viewing through the DVR/NVR browser and graphical maps.
   4. Playback controls for recorded video.
   5. Camera names brought in from the VMS.
   6. PTZ camera mouse control.
   7. Database entries for intrusion arm/disarm events on individual keypads.
   8. Database entries for intrusion alarm events.
   9. Graphical map symbols for intrusion keypads tied to camera views.
10. Intrusion devices or zones tied to camera views.

11. Alarm pop-ups and events shall include instructions and a sequence of operation to deal with events on the Intrusion Detection System, Video Management System and Electronic Access Control System.

12. Time syncing via common NTP server.

D. The Contractor shall set up a meeting between the Owner, Consultant and manufacturer to determine the exact functionality of the integration before the integration starts.

Part 3 - Execution

3.01 Testing

A. Refer to Section 27 00 00 for additional requirements.

B. Prior to energizing or testing the system, ensure the following:
   1. All products are installed in a proper and safe manner per the manufacturer’s instructions.
   2. Dust, debris, solder, splatter, etc., is removed.
   3. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
   4. All products are neat, clean, and unmarred, and parts are securely attached.

C. Contractor shall ensure that each device in the security system is functioning normally and in such a manner as to meet the functional and performance requirements in this specification.

3.02 Training

A. Refer to Section 27 00 00 for additional requirements.

B. Provide system operations, administration, and maintenance training by factory-trained personnel qualified to instruct.
   1. Contractor shall provide up to 12 hours of scheduled and dedicated training time in three (3) four (4) hour sessions for administration and investigation.
   2. Contractor shall provide up to 2 hours of scheduled and dedicated training time for maintenance including lens and dome cleaning, focusing and positioning.
   3. Provide printed training materials for each trainee, including product manuals, course outline, workbook or student guides, and written examinations for certification.
   4. Provide hands-on training with operational equipment.
   5. Training shall be oriented to the specific system being installed under this contract as designed and specified.
   6. Contractor shall provide all necessary documentation of system operating parameters prior to scheduled training sessions.

3.03 Warranty

A. Refer to Section 27 00 00 for additional requirements.
3.04 Installation Practices

A. All services provided shall be professional and conform to the highest standards for industry practices. The Owner reserves the right to halt any installation due to poor workmanship. All work shall be defect free, and the installer shall replace, at their expense, any work found to be defective.

B. The Owner reserves the right to halt any installation due to failure of Contractor to observe installation-free periods due to instructional or administrative requirements. To the maximum extent possible, the Owner will provide advance notice of such periods.

C. Contractor is responsible for providing a complete and functional video surveillance system.

D. All manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by the manufacturers, or as indicated in their published literature, unless specifically noted herein to the contrary.

E. Contractor shall follow these standards and approved submittals for locations of power supplies. The Owner intends to limit the number and location of power supplies to facilitate more effective long-term support and maintenance of the system.

3.05 Coordination

A. Contractor shall provide up to 8 hours (up to four, 2-hour sessions) of scheduled and dedicated coordination time to assist Owner with camera positioning and coordination as requested by Owner or Consultant.

3.06 Aesthetics

A. All cables and equipment terminating at panels frames shall be vertically straight, with no cables crossing each other, from twelve inches inside the ceiling area to the termination block.

B. All cable bundles shall be combed and bundled to accommodate individual termination block rows and panels.

C. For any given telecom room, a horizontal and vertical alignment for all mounting hardware will be maintained to provide a symmetrical and uniform appearance to the distribution frame.

D. All surface-mounted devices shall be firmly secured level and plumb

E. All rack mount equipment shall be securely installed.

3.07 Hardware Layout

A. Hardware positioning and layout shall be reviewed and approved by the Owner prior to construction. The review does not exempt Contractor from meeting any of the requirements stated in this document.

3.08 VMS Storage Installation Practices

A. Verify existing VMS software/hardware with District Technology Group prior to ordering.

3.09 Device Cabling/Wiring Installation Practices

A. All external wire and cables shall be supported at least every five feet from the structure or as required to maintain not more than 12” cable sag between supports and without over tensioning the cables. Provide j-hooks as needed where cable tray or raceway is not available.
B. This Contractor shall coordinate installation with Division 27 05 00 cabling Contractor to ensure there is at least 2-inches of physical separation between security cabling and voice/data cabling throughout cable path. Voice/data cabling Contractor has first claim to cable tray.

C. All cables, regardless of length, shall be labeled within 18" of both ends with an identifier that is keyed to the door, room, or corridor number as identified.

D. All cables shall have 6-foot service loops neatly coiled in the equipment room. During initial cable rough-in, this Contractor shall have sufficient slack to route anywhere within the equipment room.

E. Cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame. Cables shall be dressed in a neat and orderly fashion. Any cabling or equipment installation that is deemed unacceptable by the Owner or Consultant shall be replaced or corrected by the Contractor at no additional cost. Plastic zip ties are not allowed.

F. All cables are to run at right angles to the structure, placed above the ceiling in halls or corridors.

G. Cables shall not run above red iron joist.

H. Contractor shall make every effort to conceal wiring and other apparatus into walls, floors, and ceilings, assuming code and good engineering practice allows and suggests.

I. Ties and straps shall be installed snugly without deforming cable insulation. Ties shall be spaced at uneven intervals not to exceed four feet. No sharp burrs shall remain where excess length of the cable tie has been cut.

J. Contractor shall notify Owner immediately if obstruction or hazard is discovered in a pathway provided by others.

K. Cable shall be stored and handled to assure that it is not stretched, kinked, crushed, or abraded in any way. Bend radiuses shall meet manufacturer specifications and/or recommendations. Cable shall not be installed in ambient temperatures or moisture conditions above or below the manufacturer’s rating.

L. No splices shall be installed in any cable.

3.10 Cable Termination

A. Termination hardware (blocks and patch panels) positioning and layout shall be reviewed and approved by the Owner prior to construction. The review does not exempt Contractor from meeting any of the requirements stated in this document.

3.11 Elevator Interface

A. The Contractor shall furnish and install an elevator interface box outside of the elevator equipment room.

1. The Contractor shall provide an elevator security junction box located outside of the Elevator Machine Room, for interface of security devices to be located within the elevator cab(s). This requirement complies with ANSI A17.1 code which prevents work within the Elevator Machine Room, other than specific elevator work.

2. Security J-box shall include a keyed lockable door. Additionally, security J-box shall have proper terminal strips suitable for terminating all cables and mounting electronics within the J-box.
3. The Electrical Contractor shall provide 120VAC power to this enclosure as required to power the electronics.

4. The Contractor shall provide any data cables to this enclosure as required.

5. Electronics for access control may be placed within this enclosure.

6. Coordinate exact location of elevator security junction box with the Elevator Contractor, Architect, and Consultant, prior to installation.

7. Provide all cabling as required between the security system and elevator security J-box for all elevator interfaces.

8. Provide all required interface points for connecting to elevator travel cables.

9. Cables entering the elevator security J-box and elevator equipment room shall be appropriately labeled by the Contractor, so that the Elevator Contractor can connect the appropriate wires to travel cables. Wires should be individually labeled to separate them from other elevator functions and to assist the Elevator Contractor in making proper connection points.

10. The Contractor shall coordinate with the Elevator Contractor to ensure the appropriate cable is located within the elevator travel cable.

3.12 Fire Stopping

A. Fire stopping of openings between floors, fire-rated walls, and smoke-rated walls, created by others for This Contractor to pass cable through, shall be the responsibility of the This Contractor. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work.

B. Any openings created by or for This Contractor and left unused shall be sealed up by This Contractor.

C. This Contractor shall be responsible for creating a waterproof seal in and around any openings that This Contractor creates from the structure to the outside environment.

3.13 System Inspection

A. Contractor shall coordinate with project representative for inspection after Contractor has completed testing of entire system.

B. Contractor shall have trained Contractor representative and testing equipment on site during inspection to assist with spot verification of tests.

C. Contactor shall verify with Project Representative the precise positioning of camera aim and shall make fine adjustments as requested.

3.14 Labeling

A. Contractor shall neatly label all security devices and cabling at both ends. All labels shall be on Project as-built drawings.

3.15 Camera Installation

A. Contractor shall field verify all camera locations and positioning with Owner prior to installation.
3.16 Documentation

A. Upon completion of the installation, Contractor shall provide full documentation sets to the Consultant for approval as described in section 27 60 00. All documentation shall become the property of the Owner.

B. Documentation shall include the additional specific items detailed in the subsections below:

1. Contractor shall provide hard copy and electronic forms of the final test results.
2. Contractor shall provide a document including the following:
   a. Camera label/identifier
   b. Location of each drop by orientation/permanent landmark in the room
   c. Contractor shall provide accurate as-built Construction Drawings. The drawings are to include cable routes and device locations.

3.17 Pre-Checkout

A. The Contractor shall demonstrate the following to Owner during system demonstration.

1. The cameras are fully installed and functional.
2. Camera adjustments are complete to the Owner’s satisfaction including.
   a. Aim/Zoom
   b. Focus/Back Focus
   c. Masking Zones
   d. Motion Detection Zones
   e. Pre-Sets/Tours

3.18 Final Acceptance

A. In addition to closeout requirements in section 27 60 00, This Contractor shall demonstrate the following before final approval.

1. Owner training is complete.
2. Punch list items are complete.
3. As-built documentation is complete and submitted to Owner/Consultant.

3.19 Final Procedures

A. Perform final procedures in accordance with section 27 60 00.

End of Section
PART 1 - General

1.01 Scope

A. Refer to Section 27 00 00 for additional project scope information.

B. This section describes the requirements, criteria, and scope of work to install Intrusion Detection Systems.

C. The Contractor shall provide new intrusion detection devices as shown on the plans that will tie into the campus’s existing intrusion detection system. System to be expanded as necessary to accommodate new devices.

D. The Scope-of-work shall include, but not be limited to the following:

1. Provide necessary materials, hardware, software and cabling required to furnish new devices to be tied into the existing system described by this specification document and depicted on accompanying project drawings.

2. Provide low voltage signal, control, and power cables to and from power supplies, remote panels, expansion panels, and other devices as required for a complete turnkey installation explicitly indicated on drawings and fully described by this document.

3. Coordinate with Electrical Contractor (EC) for provision of conduits and high voltage power where necessary.

4. Install all System devices, materials, and equipment, and program and/or adjust as indicated by the equipment manufacturers' published literature, unless specifically noted herein to the contrary by this document.

5. Contractor shall be responsible for any and all related system programming.

6. Furnish the following, as needed, to provide a complete and fully functional system:

   a. Control Panel(s)
   b. Expansion Panel(s)
   c. Door contacts
   d. Motion Detectors
   e. Wire and Cable
   f. Audible Alarm/Sirens audio alert devices
   g. Cabinets and enclosures
   h. UPS and Batteries
   i. Hangers, supports and cable management devices
   j. Other necessary equipment to meet the installation need as implied

1.02 Related Work

A. Section 27 00 00 – General Technology Requirements
1.02 Definitions

A. Refer to Section 27 00 00 for additional definitions.

1.03 Reference Standards and Codes

A. Refer to Section 27 00 00 for additional requirements.

1.04 Qualifications

A. Refer to Section 27 00 00 for additional requirements.

1.05 Pre-Construction Submittals

A. The Contractor shall submit the intrusion detection hardware layouts which includes the number of controllers, sub-panels and other associated devices per location.

B. The Contractor shall submit full power calculations which includes the anticipated power loads, number and type of power supplies including all power supply boards, number of 120VAC circuits required, battery backup including the quantities of batteries to meet requirements, PoE loads, fire alarm connection requirements, etc.

C. Refer to Section 27 00 00 for additional requirements.

1.06 Pre-installation Procedures

A. Refer to section 27 00 00 for additional requirements.

1.07 Construction Progress Submittals

A. Refer to Section 27 00 00 for additional requirements.

1.08 Closeout Submittals

A. Refer to Section 27 00 00 for additional requirements.
1.10 General Summary

A. This section includes products and execution requirements relating to furnishing and installing intrusion detection devices as described in this specification, and indicated on project drawings.

B. Contractor shall provide low voltage power and control lines to and from power supplies, remotely controlled equipment, and other devices, even though not explicitly indicated on drawings or listed in equipment tables.

C. Contractor shall be responsible for the coordination and provision of high voltage power and conduits where necessary.

D. Contractor is responsible for providing own cable and sleeve penetrations, coring, and other infrastructure work unless specifically noted otherwise.

E. All manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by manufacturers, or as indicated in their published literature, unless specifically noted herein to the contrary.

F. The system shall include all hardware and software, control panels, interfaces, communication devices, cable/wire, raceways, enclosures, mounting hardware, and all other equipment as required for a turnkey Intrusion Alarm system.

G. A general description, as well as detailed functional and technical drawings, for the complete intrusion alarm system at all site locations. This also includes all manuals, documentation, and operational information necessary for the maintenance, training, and operation of the intrusion alarm system.

H. The Contractor shall be responsible for any and all related programming.

I. System Functions:

1. The intent of the system is to detect intrusion and motion events within the building and to notify the Owner’s monitoring company of such events.

2. The system shall provide both silent and audible intrusion alerts that can be used together or separately.

3. The system shall be zoned (programmed) with logical (Owner defined) multiple access zones or sections while not deactivating the total system.

4. Door contacts shall be individual zones, except for multiple sensors or detectors motion the same door set or window/glass set.

1.11 System Architecture

A. The intrusion alarm system shall provide zoned detection and primary and secondary notification of unwanted and forced entries into a facility. Security devices such as door contacts and motion detectors will be installed at specified areas and provide on and off-site detection, and in-turn notification of these unwanted events. The Owner will provide the 24-hour alarm monitoring company information to the Contractor for programming.

B. The intrusion alarm system shall provide motion detection and door contact coverage of all egress and ingress doors and roof hatches of the facility.

C. Network
1. The intrusion alarm system hardware shall be capable of interfacing to an IEEE 802.3 standard local area network (LAN).

1.12 Programming
   A. All final software configuration and programming shall require consultation with the Owner.

Part 2 - Products

2.01 Substitutions
   A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Alarm Control Panel
   1. New devices shall be tied into existing system at each campus. Additional panels as part of the existing system may be required in new IDF’s at certain campuses. Refer to drawing set for further information.

2.03 Keypads
   A. No keypads shall be used. System shall be fully integrated with the Access Control System and shall be disarmed when an authorized person swipes their badge at an entrance card reader.

2.04 Door Contacts/Door Position Switches
   A. Sealed and potted magnetic reed switch in contact housing.
   B. Provide DPDT contacts at all locations – every door contact shall connect to both the intrusion system and the access control system
   C. Provide color that matches door as close as possible.
   D. Provide recessed switch whenever possible.
   E. Provide UTC Interlogix 1078 Series for recessed applications.
      1. Or approved equal.
   F. Provide UTC Interlogix 1045 Series for surface mount applications.
      1. Or approved equal.
   G. Provide UTC Interlogix 2200 Series for overhead door applications.
      1. Or approved equal.

2.05 Motion Detectors
   A. The motion detector shall be a multi-technology device with anti-mask.
   B. Reduces false alarms by sensing both heat and physical motion.
   C. 60’ x 80’ standard coverage.
D. Can be mounted between 8'-25' with no adjustments.

E. Provide with appropriate mounting hardware.

F. White.
   1. Wall Mount – Bosch ISC-PDL1-WA series
   2. Ceiling Mount – Bosch DS9370
   3. Or approved equal

2.06 Acoustic Glass Break Detectors

A. 25', 360 degree detection radius.

B. White.

C. Manufacturer:
   1. Bosch DS1102i series.
   2. Or approved equal

2.07 Device Cable Types by Use

A. Door Contacts, Panic/Duress Buttons: 22-gauge, two-conductor, unshielded, stranded cable shall be provided for all door contacts. The cable shall be white in color and plenum rated (West Penn, General Cable, and Genesis). Door contact cabling shall not exceed 500 feet from the nearest panel.

B. Motion Detectors: 22-gauge, four-conductor, shielded, stranded cable shall be provided for all motion detectors. The cable shall be white in color and plenum rated (West Penn, General Cable, and Genesis). Motion detector cabling shall not exceed 500 feet from the intrusion alarm expansion model or nearest alarm panel on 22-guage.

C. Follow manufacturer’s recommendations for all systems cabling.

2.08 Access Control/Video Surveillance/Intrusion Detection Integration

A. The electronic access control system shall be integrated with the video surveillance system and intrusion detection system.
   1. The access control/intrusion detection interface shall be via an RS-232 or Ethernet interface. Contact closure integration shall only be utilized if the system is existing and cannot be upgraded to support RS-232 or Ethernet. The Contractor shall supply all necessary expansion boards if contact closure integration will be required.
   2. The access control/video surveillance integration shall be via a native IP interface.
   3. The video surveillance/intrusion detection interface shall be via an RS-232 or Ethernet interface. Contact closure integration shall only be utilized if the system is existing and cannot be upgraded to support RS-232 or Ethernet. The Contractor shall supply all necessary expansion boards if contact closure integration will be required.

B. The Contractor shall provide any and all licensing to integrate the systems together including any additional items to be added to the yearly maintenance agreement.
C. The following minimum features shall be included in the integration; the following list is not all inclusive or exhaustive. The integration shall be a turnkey solution:

1. Call up live and/or recorded video from an alarm or event.
2. Graphical maps showing camera icons.
3. “Mouse over” camera viewing through the DVR/NVR browser and graphical maps.
4. Playback controls for recorded video.
5. Camera names brought in from the VMS.
6. PTZ camera mouse control.
7. Database entries for intrusion arm/disarm events on individual keypads.
8. Database entries for intrusion alarm events.
9. Graphical map symbols for intrusion keypads tied to camera views.
10. Intrusion devices or zones tied to camera views.
11. Alarm pop-ups and events shall include instructions and a sequence of operation to deal with events on the Intrusion Detection System, Video Management System and Electronic Access Control System.
12. Time syncing via common NTP server.

D. The Contractor shall set up a meeting between the Owner, Consultant and manufacturer to determine the exact functionality of the integration before the integration starts.

Part 3 - Execution

3.01 Testing
   A. Refer to Section 27 00 00 for additional requirements.

3.02 Training
   A. Refer to Section 27 00 00 for additional requirements.

3.03 Warranty
   A. Refer to Section 27 00 00 for additional requirements.
   B. Contractor shall guarantee all materials, equipment, etc., for two (2) years from date of substantial completion of work. This guarantee shall include labor, material, and travel time.
   C. All Intrusion Alarm systems, materials, and labor shall be under warranty for 1 year from date of final acceptance.

3.04 General
   A. Prerequisites
      1. The Contractor shall maintain a competent (single point of contact) project supervisor, along with competent technical personnel acceptable to the Owner and Consultant, during the entire installation process. Best efforts shall be made to avoid change of the
project supervision during the project without prior written approval from the Owner and/or Consultant.

2. The Contractor installing any equipment/devices shall be responsible for providing all interconnecting cables to and/or between same equipment that may be required to make equipment fully operational.

B. Requirements and Responsibilities

1. The Contractor shall provide, furnish, deliver, transport, erect, install, configure, and connect completely all of the material and equipment described herein or depicted on project drawings. The Contractor shall supply all other incidental material required, such as interconnecting cables, to make the work complete, and to install all systems in a turnkey operating condition.

2. Perform this work in accordance with acknowledged industry and professional standards and practices, existing build conditions, and as specified herein. Proved and install all materials, devices, components, and equipment for complete, operational systems.

3. Coordinate all efforts and verify field conditions with those of related trades. In the event of any conflicts, delays or improper preparatory work by others, notify the Owner or Owner’s Consultant: The Owner and Owner’s Consultant’s decision will be binding.

3.05 Installation Practices

A. All services provided shall be professional and conform to the highest standards for industry practices. The Owner and Owner’s Consultant reserve the right to halt any installation due to poor workmanship. All work shall be defect free, and the installer shall replace, at their expense, any work found to be defective.

B. The Contractor shall exercise care during installation - damage to cables or equipment will not be accepted. The Contractor shall remove any damaged cabling or equipment and replace with new.

C. Contractor is responsible for providing a complete and functional intrusion alarm system.

D. Contractor shall provide low voltage power and control lines to and from power supplies, remotely controlled equipment, and other devices, even though not explicitly indicated on drawings or listed in equipment tables.

E. All manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended by the manufacturers, or as indicated in their published literature, unless specifically noted herein to the contrary.

F. The Contractor shall follow these standards and approved submittals for locations of power supplies. The Owner intends to limit the number and location of power supplies to facilitate more effective long-term support and maintenance of the system.

G. The Contractor shall provide rack shelves or rack mounting ears for any equipment that is not rack mountable. All equipment installed using shelves shall be fastened to the rack shelf.

H. Install plates as required on back boxes where they exist. Provide cut-in back boxes where boxes do not exist.

I. Install surface mounted cable raceway systems that match the surface color and/or the other surface mounted raceways, where cables cannot run within fishable walls.
J. The Contractor installing any RF devices shall be aware that RF devices may cause interference to equipment, and shall take whatever precautions necessary to avoid causing interference.

K. The Owner will provide programming information needed to help Contractor with configuration of system. The Contractor shall have the responsibility to program the system, assure proper communications between controlling points and any monitoring companies, and to adjust any system or device causing false alarm conditions.

L. Consideration shall be given not only to operation efficiency, but also to overall aesthetic factors.

3.06 Coordination

A. Contractor shall provide up to 4 hours (up to two, 2-hour sessions) of scheduled and dedicated coordination time to assist Owner with sequence of operation, zone coordination, rule creation and coordination as requested by Owner or Consultant.

3.07 Training

A. Provide system operations, administration, and maintenance training by factory-trained personnel qualified to instruct.

1. Contractor shall provide up to 4 hours of scheduled and dedicated training time in two (2) two (2) hour sessions for administration and investigation.

2. Provide printed training materials for each trainee, including product manuals, course outline, workbook or student guides, and written examinations for certification.

3. Provide hands-on training with operational equipment.

4. Training shall be oriented to the specific system being installed under this contract as designed and specified.

5. Contractor shall provide all necessary documentation of system operating parameters prior to scheduled training sessions.

3.08 Support

A. The Contractor shall make available technical resources, as deemed necessary by the Owner, for database integration projects.

3.09 Aesthetics

A. All cables terminating at the panel frames shall be vertically straight, with no cables crossing each other, from twelve inches inside the ceiling area to the termination block.

B. All cable bundles shall be combed and bundled to accommodate individual termination block rows and panels.

C. A horizontal and vertical alignment for all mounting hardware shall be maintained to provide a symmetrical and uniform appearance to the distribution frame.

D. All surface-mounted devices shall be firmly secured and level.
3.10 Hardware Layout
   A. Hardware positioning and layout shall be according to project drawings.

3.11 Device Cabling/Wiring Installation Practices
   A. Contractor shall coordinate with the Electrical Contractor their requirements for conduits and proper AC power to service all equipment installed by Contractor, in locations where power is not available.

   B. Contractor shall provide for proper ground system to all equipment.

   C. Each cable group that can cause interference to another group shall be separated by sufficient distance so as not to cause signal contamination or interference.

   D. All external wire and cables shall be supported at least every five feet from the structure, or as required to maintain not more than 12" cable sag between supports and without over tensioning the cables.

   E. All cables, regardless of length, shall be marked with indelible color-coded labels within 18" of both ends with an identifier that is keyed to the door, room, or corridor number as identified. Labels shall be directly hot stamped or factory stamped, closed sleeve method. Adhesive strip labels may only be used if protected by transparent heat-shrink tubing. There shall be no unmarked cables at any place in any part of any system. Marking codes used on cables shall correspond and be shown clearly on as-built drawings.

   F. Each cable shall be marked at all cable ends with a standard nomenclature (Device, #, closet letter).

   G. All cables shall be separated into like groups, according to signal or power levels, and routed separately to eliminate signal contamination and crosstalk - this includes both inside and outside of equipment racks.

   H. All cables shall have 6-foot service loops neatly coiled in accessible ceiling. During initial cable rough-in, the Contractor shall have sufficient slack to route anywhere within Telecommunications Room. Coordinate exact panel and power supply mounting locations with Electrical Contractor.

   I. Cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame. Velcro straps shall be installed snugly without deforming cable insulation. Cables shall be dressed in a neat and orderly fashion. Any cabling or equipment installation that is deemed unacceptable by the Owner or Consultant shall be replaced or corrected by the Contractor at no additional cost.

   J. Cable Ties shall be installed snugly without deforming cable insulation. Ties shall be spaced at uneven intervals not to exceed four feet. No sharp burrs shall remain where excess length of the cable tie has been cut.

   K. All cables are to run at right angles to the structure, placed above the ceiling in halls or corridors.

   L. Cables shall not run above red iron joist.

   M. Contractor shall make every effort to conceal wiring and other apparatus into walls, floors, and ceilings, assuming code and good engineering practice allows and suggests.
N. Contractor shall notify Owner or Owner’s Consultant immediately if obstruction or hazard is discovered in a pathway provided by others.

O. Cable shall be stored and handled to assure that it is not stretched, kinked, crushed, or abraded in any way. Bend radiuses shall meet manufacturer specifications and/or recommendations. Cable shall not be installed in ambient temperatures or moisture conditions above or below the manufacturer’s rating.

P. No splices shall be installed in any cable.

Q. No security device cabling shall have an accessible disconnect outside of a secured equipment room or within a backbox.

R. Any exterior exposed will be contained in waterproof conduit with the appropriate waterproof fittings.

S. All cables are to run at right angles to the structure, placed above the ceiling in halls and corridors.

T. Contractor shall make every effort to conceal wiring and other apparatus into walls, floors and ceilings, assuming any applicable codes and good engineering practice allows and suggests.

U. All cabling systems installed in public areas shall be installed within walls, ceiling or floors or within surface wiring pathways as dictated by codes and good engineering practices.

V. Contractor shall notify Owner or Owner’s Consultant immediately if obstruction or hazard to cable paths are discovered and seek corrective actions.

W. The cables shall be supported by properly insulated wire support hangers, bridal rings, “D” rings, ladder cable tray, or inner duct as may be necessary to support cables.

X. Contractor shall seal any cable penetrations they may use or make where the penetration is part of a firewall or acoustic barrier.

3.12 Equipment Cabinet Wire and Cable Installation

A. All power cables, control cables, and high level cables shall be grouped to one side of the equipment rack while low level cables grouped to the other side.

B. All equipment rack wiring and cabling shall be neatly laced, and ends dressed with heat shrink tubing, and all cables shall have service loops between the horizontal tie bar and the connection to equipment. Rack cabling shall be adequately supported with tie wraps or Velcro wire wraps, and horizontal support bars to rack frame as it enters or exits the front or back of equipment.

C. All equipment rack wiring and cabling shall be neatly dressed.

D. Rack cabling shall be adequately supported with Velcro wire wraps and horizontal support cable managers fastened to rack frame.

3.13 Connectors/Connections

A. Moisture Resistance: All connectors shall be crimped or applied in such a way as to prevent moisture from entering the connector or cable.
B. Preparation: Cables shall be carefully prepared and connectors installed as directed by the manufacturer. Proper stripping devices and crimping tools shall be used.

C. Terminations: Connectors shall be carefully fitted to mating devices on equipment to avoid damage to mating contacts, inserts, or bodies. Specialized terminations shall be made in a neat and secure manner, suited to the service of the wire, and as directed by the manufacturer. In all cases, where the manufacturer specifies the terminations, those terminations shall be used.

D. Termination Testing: The strength of the termination shall be tested by manually pulling on the connector and cable. Any terminations that exhibit movement, loose cable, or insecure connections shall be re-terminated.

3.14 Physical Security Integration

A. The intrusion detection system shall be integrated with the electronic access control system and the surveillance system.

1. The access control/intrusion detection interface shall be via an Ethernet interface. Contact closure integration shall only be utilized if the system is existing and cannot be upgraded to support Ethernet. The Contractor shall supply all necessary expansion boards if contact closure integration will be required.

2. The access control/video surveillance integration shall be via a native Ethernet interface.

3. The video surveillance/intrusion detection interface shall be Ethernet interface. The Contractor shall supply all necessary expansion boards as required.

B. The Contractor shall provide any and all licensing to integrate the systems together including any additional items to be added to the yearly maintenance agreement.

C. Refer to the Electronic Access Control and Video Management System specification sections for specific integration requirements.

D. The Intrusion system shall be time syncing to common NTP server.

E. The Contractor shall set up a meeting between the Owner, Consultant and manufacturer to determine the exact functionality of the integration before the integration starts.

3.15 Special Techniques

A. Waterproofing: Contractor shall be responsible for creating a waterproof seal in and around any openings the Contractor creates, or are created by others for use by Contractor, that enter or exist in a structure to the outside environment.

3.16 Fire Stopping

A. Fire stopping of openings between floors, fire-rated walls, and smoke-rated walls, created by others for the telecommunication Contractor to pass cable through, shall be the responsibility of the security Contractor. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work.

B. Any openings created by, or for Contractor, and left unused, shall be sealed up as part of this work by the telecommunication Contractor.
3.17 Test Requirements for Device Cabling
   A. Contractor shall perform continuity tests to ensure cables are free of shorts within the pairs, and shall verify cables for continuity, pair validity and polarity, and conductor position.

3.18 System Testing Procedures
   A. Prior to energizing or testing the system, ensure the following:
      1. All products are installed in a proper and safe manner per the manufacturer’s instructions.
      2. Dust, debris, solder, splatter, etc., is removed.
      3. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
      4. All products are neat, clean, and unmarred, and parts are securely attached.
   B. Contractor shall ensure that each device in the security system is functioning normally and in such a manner as to meet the functional and performance requirements in this specification.

3.19 System Inspection
   A. Contractor shall coordinate with Consultant and Owner’s Safety and Security Department for inspection after Contractor has completed testing of entire system.
   B. Contractor shall have trained Contractor representative and testing equipment on site during inspection to assist with spot verification of tests.
   C. Contractor shall demonstrate to Consultant and Owner’s Safety and Security Department the functionality of the system, including the selection of various display modes and accessing system functions.
   D. Contractor shall verify with Consultant and Owner’s Safety and Security Department the precise positioning of all devices and shall make fine adjustments as requested.

3.20 Labeling
   A. Contractor shall neatly label all security devices and cabling at both ends. All labels shall be on project as-built drawings.
   B. Contractor shall label both ends of the cable within four (4) inches of the termination with the same label identifier. These will be machine printed, Brady (or equivalent) labels.
   C. Panels shall have labels showing cable numbers and far end locations for each cable terminated in the cabinet.

3.21 Documentation
   A. Upon completion of the installation, Contractor shall provide full documentation sets to the Consultant for approval. All documentation shall become the property of the Owner.
   B. Documentation shall include the items detailed in the subsections below:
      1. Contractor shall provide hard copy and electronic forms of the final test results.
      2. Contractor shall provide a document including the following:
a. Device label/identifier

b. Location of each device by room or corridor number

C. Contractor shall provide accurate as-built Construction Drawings. The drawings are to include cable routes and device locations.

D. Consultant will provide floor plans in paper and electronic formats (".dwg," AutoCAD and ".dxf") on which as-built construction information can be added. The Contractor shall modify these documents accordingly to denote as-built information as defined above and then return the documents to the Owner.

3.22 Final Acceptance

A. The Contractor shall demonstrate the following before final approval.

1. Owner training is complete.

2. Punch list items are complete.

3. As-built documentation is complete and submitted to Owner/Consultant.

3.23 Closeout Procedures

A. Closeout Submittals: Contractor shall provide closeout documentation to the Consultant. The Consultant shall receive the closeout submittals no less than 72 hours prior to the scheduled inspection time.

B. Inspection: Contractor shall be present for the inspection by the Consultant. Contractor shall supply all testing equipment needed to verify compliance with the specifications.

C. Punch List: Work or materials found to be incomplete, of unsatisfactory quality, failing to meet written system specifications, and/or unacceptable to the Consultant, shall be documented by the Consultant and provided to Contractor to rectify.

D. Re-Inspection: If a re-inspection is necessary, the costs of the Consultant's additional travel, hours, and expenses may be deducted by the Owner from the contract amount due Contractor.

E. Punch List Approval: The punch list shall be considered complete only after having been signed by the Owner and Consultant.

3.24 Cleaning

A. Prior to system final turnover to Owner:

1. Remove all dirt and debris from equipment racks and equipment rooms.

2. Clean all equipment filters, vents, and fans.

3. Clean all enclosures and back box interiors thoroughly before installing plates, panels, or covers.

End of Section
SECTION 28 05 00  COMMON WORK RESULTS FOR ELECTRONIC SAFETY & SECURITY

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Electronic safety and security equipment coordination and installation.
      2. Sleeves for raceways and cables.

1.3 COORDINATION
   A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
      1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
      2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
      3. To allow right of way for piping and conduit installed at required slope.
      4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
   B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
   C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
   D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES
   A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.2 GROUT
   A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION
   A. Comply with NECA 1.
   B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

D. Cut sleeves to length for mounting flush with both surfaces of walls.

E. Extend sleeves installed in floors 2 inches above finished floor level.

F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 28 05 00
SECTION 28 31 11  DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes the following work:

1. Extension of the existing fire alarm systems at the following campuses:
   a. Dessau Middle School
   b. Kelly Lane Middle School
   c. Park Crest Middle School
   d. Westview Middle School
   e. Connally High School

2. Extension of the existing fire alarm system with voice evacuation at Cele Middle School.

3. Extension of the existing fire alarm system and the addition of voice evacuation system at Pflugerville Middle School. Voice evacuation system will be installed only in the renovated and new spaces that are a part of the work of this contract, but shall be sized to provide coverage by addressable devices for the entire building in the future, plus 20% space capacity. Each signaling line circuit (SLC) shall be limited to 80% of its total device capacity.

B. Section Includes:

1. Voice evacuation panel.
3. System smoke detectors.
4. Duct smoke detectors.
5. Heat detectors.
7. Device guards.
10. Digital alarm communicator transmitter.
11. Network communications.

C. Related Sections include the following:

1. Division 26 Section "Raceways and Boxes for Electrical Systems" for raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.
B. FACP: Fire Alarm Control Panel.
C. HLI: High Level Interface.
E. PC: Personal computer.
1.4 SYSTEM DESCRIPTION

A. A. Noncoded, UL-certified addressable system, with multiplexed signal transmission and speaker/strobe evacuation, dedicated to fire-alarm service only. B. Automatic sensitivity control of certain smoke detectors.

B. All components provided shall be listed for use with the selected system.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals” for products specified under PART 2 – PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals”.

C. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.

D. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in the “Documentation” section of the “Fundamentals” chapter in NFPA 72.
   2. Include plans, elevations, sections, details, and attachments to other work.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
   4. Detail assembly and support requirements.
   5. Include voltage drop calculations for notification-appliance circuits.
   6. Include battery-size calculations.
   7. Include input/output matrix.
   8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
   9. Include performance parameters and installation details for each detector.
   10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
      a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
      b. Show field wiring required for HVAC unit shutdown on alarm.
      c. Locate detectors according to manufacturer’s written recommendations.
   12. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
   13. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

E. General Submittal Requirements:
   1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified, fire-alarm technician; Level III minimum.
   c. Licensed or certified by authorities having jurisdiction.

F. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to
   submittals listed above, indicate compliance with performance requirements and design criteria,
   including analysis data signed and sealed by the qualified professional engineer responsible for their
   preparation.
   1. Drawings showing the location of each notification appliance and smoke and heat detector,
      ratings of each, and installation details as needed to comply with listing conditions of the device.
   2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection,
      complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure
      levels for audible appliances.
   3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.6 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For Installer.
   B. Field quality-control reports.
   C. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency,
      operation, and maintenance manuals.
      1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include
         the following:
         a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in
            NFPA 72.
         b. Provide "Fire Alarm and Emergency Communications System Record of Completion
            Documents" according to the "Completion Documents" Article in the "Documentation"
            section of the "Fundamentals" chapter in NFPA 72.
         c. Complete wiring diagrams showing connections between all devices and equipment. Each
            conductor shall be numbered at every junction point with indication of origination and
            termination points.
         d. Riser diagram.
         e. Device addresses.
         f. Record copy of site-specific software.
         g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and
            Maintenance" chapter in NFPA 72, and include the following:
            1) Equipment tested.
            2) Frequency of testing of installed components.
            3) Frequency of inspection of installed components.
            4) Requirements and recommendations related to results of maintenance.
            5) Manufacturer's user training manuals.
         h. Manufacturer's required maintenance related to system warranty requirements.
         i. Abbreviated operating instructions for mounting at fire-alarm control unit and each
            annunciator unit.
   B. Software and Firmware Operational Documentation:
      1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 5 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 5 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 5 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper-proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.
C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
E. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.10 PROJECT CONDITIONS

A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.
B. Coordinate the Work of this section with the Work of other sections, including sprinkler systems, elevators, HVAC systems, and security/door locking systems.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: One (1) year from date of Substantial Completion.

B. Fire Alarm Contractor shall guarantee twenty-four (24) hour response time and warranty service. Emergency response time shall not exceed two (2) hours. Non-compliance during warranty period will
force Owner to request the fire alarm manufacturer to re-appropriate the warranty service to another authorized distributor. No exceptions or substitutions will be considered.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products compatible with the existing fire alarm control panel manufacturer on each campus. The existing fire alarm control panel manufacturers are as follows:

1. Cele Middle School: Silent Knight.
2. Dessau Middle School: Silent Knight.
3. Kelly Lane Middle School: Silent Knight.
4. Park Crest Middle School: Silent Knight.
5. Pflugerville Middle School: Silent Knight.
6. Westview Middle School: Silent Knight.
8. Hendrickson High School: Silent Knight.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Carbon monoxide detectors.
6. Automatic sprinkler system water flow.

B. Fire-alarm signal shall initiate the following alarm condition actions:

1. At the panel and any remote annunciator, a system alarm LED shall flash as appropriate and a local sounding device shall activate.
2. Identify alarm and specific initiating device addressable point at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3. Sound a distinctive evacuation signal throughout the entire building where specific initiating device is in alarm.
4. Simultaneously activate all flashing visual alarm assemblies associated with audible indicators.
5. Unlock electric door locks in designated egress paths.
6. Fire safety control functions related to providing free egress from the facility shall be activated on general alarm, including the automatic opening of any controlled motorized security gate/grill and automatic unlocking for egress of any controlled non-fire rated security doors or gates.
7. Fire safety control functions conditional on the detection of an alarm condition in one or more designated adjacent area smoke detectors shall be activated independently on a one-for-one basis, these functions may include air handler shutdown of units without a duct mounted smoke detector, electromagnetic door hold back release, release of overhead coiling or hinged fire or smoke rated doors or shutters (those designed to close in order to control the spread of fire or smoke), and any other conditional operations such as elevator recall.
8. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode. Shut down HVAC equipment rated 2000 cfm or greater that circulate air on the alarm floor.
9. Recall elevators to primary or alternate recall floors.
10. Activate an automatic telephone dialer and alarm contact closure for use with approved central station monitoring service. Owner provides NFPA 71 central station connection and maintains that service.
11. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch.
   2. Alert and Action signals of air-sampling detector system.
   3. Elevator shunt-trip supervision.
   4. Independent fire-detection and -suppression systems.
   5. User disabling of zones or individual devices.
   6. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
   4. Loss of primary power at fire-alarm control unit.
   5. Ground or a single break in internal circuits of fire-alarm control unit.
   6. Abnormal ac voltage at fire-alarm control unit.
   7. Break in standby battery circuitry.
   8. Failure of battery charging.
   9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. Supervisory signal initiation or Trouble signal initiation shall initiate the following actions:
   1. At the panel and any remote annunciator, a system supervisory alarm LED or trouble LED shall flash as appropriate and a local sounding device shall activate. Audible supervisory or trouble alerts that have been silenced shall automatically resound every twenty-four hours or less until repairs are made.
   2. Initiate notification appliances.
   3. Identify specific device addressable point initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
   4. After a time delay of 200 seconds, transmit a TROUBLE or SUPERVISORY signal to the remote alarm receiving station.
   5. Transmit system status to building management system.
   6. Detection of a supervisory alarm in a duct mounted smoke detector shall initiate shutdown of the associated air handler and closing of any smoke dampers or fire/smoke dampers located in that unit’s duct system on a conditional one-for-one basis.

2.3 MANUAL FIRE-ALARM BOXES

A. Manufacturer: Silent Knight model SK-PULL-DA.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer’s surface back box.
   1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key-operated switch, keyed alike to FACP.
3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery powered audible horn intended to discourage false-alarm operation. Lowering and realigning the shield shall silence the horn. The horn shall provide 85 dB at 10 feet and be powered by a standard 9-volt alkaline replaceable battery. Provide Stopper II Manual.
4. Station Protector with horn as manufactured by Safety Technology International, Inc. (STI) or approved equal.

2.4 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V DC, nominal.
2. Detectors shall be two-wire type.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status. Status LEDs shall flash under normal conditions, indicating the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating an alarm condition has been detected and verified.
6. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Multiple levels of detection sensitivity for each sensor.
   b. Sensitivity levels based on time of day.
7. Detectors shall be UL listed with respective control panel.

B. Photoelectric Smoke Detectors:
1. Manufacturer: Silent Knight model SK-PHOTO-W with B300-6 6-inch base or equivalent.
2. Detector shall operate by the photoelectric light-scattering principal using an LED light source to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
3. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
4. Detector shall provide a maintenance alert feature whereby the detector shall initiate a trouble condition should the unit’s sensitivity approach the outside limits of the normal sensitivity window.
5. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector: a. Primary status.
   a. Device type.
   b. Present average value.
   c. Present sensitivity selected.
   d. Sensor range (normal, dirty, etc.).
6. Detector shall be semi-flush ceiling mounted and provided with modular detector head with twist-lock base. Detectors shall be provided in smooth attractive white finish, and be sealed against dirt, vermin, and backpressure. Detectors shall be provided with fine mesh insect/contaminate screen.

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Manufacturer: Silent Knight model SK-DUCT or DH400OE-1 (watertight) housing with base, DSTx series sampling tube, EXT metal exhaust tube duct, SK-PHOTO photoelectric detector head, and RA100Z remote LED, or equivalent.
2. Detector shall operate by the photoelectric light-scattering principal using an LED light source to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. The detector shall operate in air velocities of 300 to 4,000 ft./min. without a shift in sensitivity.
3. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
4. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector: a. Primary status.
   a. Device type.
   b. Present average value.
   c. Present sensitivity selected.
   d. Sensor range (normal, dirty, etc.).
5. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
6. Each sensor shall have multiple levels of detection sensitivity.
7. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.5 HEAT DETECTORS

A. Manufacturer: Silent Knight model SK-HEAT-ROR or SK-HEAT-HT with SK B210LP 6-inch base or equivalent.

B. General Requirements for Heat Detectors: Comply with UL 521.
1. Heat detectors shall connect via two wires to an intelligent control panel loop and be resettable from the control panel. The detectors shall use dual electronic thermostats to measure temperature levels in its chamber. The detector shall, on command from the control panel, send data to the panel representing the analog temperature level.
2. Temperature sensors shall test for and communicate the sensitivity range of the device.
3. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status. Status LEDs shall flash under normal conditions, indicating the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating an alarm condition has been detected and verified.
4. Detector shall be semi-flush ceiling mounted and provided with modular detector head with twist-lock base. Detectors shall be provided in smooth attractive white finish.
5. Detectors shall be UL listed with respective control panel.

C. C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
2.6 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word “FIRE” is engraved in minimum 1-inch-high letters on the lens.
   1. Manufacturer: Silent Knight model SCWL series or equivalent.
   2. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.
   3. Mounting: Ceiling mounted unless otherwise indicated.
   4. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   5. Flashing shall be in a temporal pattern, synchronized with other units.

C. Voice/Tone Notification Appliances:
   1. Manufacturer: Silent Knight model SPCWL series or equivalent for ceiling mounted speaker only. Silent Knight model SPSCWL series for combination speaker/strobe units.
   2. Comply with UL 1480.
   3. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
   4. High-Range Units: Rated 2 to 15 W.
   5. Low-Range Units: Rated 1 to 2 W.
   6. Mounting: Flush or surface mounted and bidirectional.
   7. Matching Transformers: Tap range matched to acoustical environment of speaker location.
   8. System shall automatically provide for speakers to broadcast a pre-recorded voice message operation on alarm that shall include an audible signal temporal pattern (Code 3) meeting ANSI S3.41 standards.
   9. System shall also provide for manual voice capability by keying the microphone, which shall override the pre-recorded message. The system shall be capable of emergency voice announcements at any time, whether the FACP is in alarm or not.

2.7 STROBE SIGNAL POWER EXPANDERS

A. Manufacturer: Silent Knight model 5495 or 5499 distributed power modules, Silent Knight model 5496 or 5895XL intelligent power modules, or equivalent.
B. Provide additional power supplies as required for strobe notification appliance circuits or as a remote power supply.
C. For all power supplies serving strobe signals, the interface with the main fire alarm control panel shall carry a signal to synchronize the flash timing of all interior strobes in the system in a code 3 pattern at 1 Hz.
D. Each power supply shall individually report a trouble condition including battery charging failure, battery failure, NAC loss, AC power loss, power brownout, or ground fault detection.
E. A trouble condition on an external power supply shall not interfere with normal operation of the rest of the system.

F. In the event of a trouble condition, each power supply shall provide location annotated individual point supervisory incident reporting to the main fire alarm control panel. This may be accomplished using one addressable module per power supply or via power supplies with multiplexed system bus communication or an integrated addressable interface.

G. The signal power expander supply/charger and batteries shall supply power limited 24 VDC operating and emergency power. The charger shall be capable of maintaining batteries in a fully charged state without damage and of bringing batteries from a fully discharged to a fully charged state within 48 hours of normal operation. Provide sufficient battery capacity for operation without AC power for twenty-four hours of normal supervision and five minutes alarm operation at the end of this period; include a 20% safety factor in battery calculations to ensure adequate performance for the service life of batteries.

2.8 VOICE EVACUATION SPEAKER SIGNAL POWER EXPANDERS

A. Manufacturer: Silent Knight model EVS-50W, EVS-100W, or EVS-125W voice evacuation units, or equivalent.

B. Provide additional power supplies as required for voice evacuation speaker notification appliance circuits, for strobe notification appliance circuits, or as a remote power supply.

C. For all power supplies serving strobe signals, the interface with the main fire alarm control panel shall carry a signal to synchronize the flash timing of all interior strobes in the system in a code 3 pattern at 1 Hz.

D. For all power supplies serving strobe signals, the interface with the main fire alarm control panel shall carry a signal to synchronize the flash timing of all interior strobes in the system in a code 3 pattern at 1 Hz.

E. Each power supply shall individually report a trouble condition including battery charging failure, battery failure, NAC loss, AC power loss, power brownout, or ground fault detection.

F. A trouble condition on an external power supply shall not interfere with normal operation of the rest of the system.

G. In the event of a trouble condition, each power supply shall provide location annotated individual point supervisory incident reporting to the main fire alarm control panel. This may be accomplished using one addressable module per power supply or via power supplies with multiplexed system bus communication or an integrated addressable interface.

H. The evacuation signal power expander supply/charger and batteries shall supply power limited 24 VDC operating and emergency power. The charger shall be capable of maintaining batteries in a fully charged state without damage and of bringing batteries from a fully discharged to a fully charged state within 48 hours of normal operation. Provide sufficient battery capacity for operation without AC power for twenty-four hours of normal supervision and five minutes alarm operation at the end of this period; include a 20% safety factor in battery calculations to ensure adequate performance for the service life of batteries.

2.9 REMOTE POWER SUPPLY UNITS FOR PERIPHERAL

A. Provide remote power supplies as required for proper system operation.

B. Remote power supplies shall be provided with local intelligence compatible with the digital multiplex network, so they have a unique address, providing the ability to monitor the supply for loss of power, shorts, grounds and other supervisory functions.

C. Where required by the fire alarm system manufacturer, remote power supplies shall be provided that will provide sufficient current to drive audio/visual or other required devices.
D. These units shall be located in electrical closets, mechanical rooms or similar spaces. They shall not be installed in finished areas, storage rooms, etc., without the permission of the Engineer. All locations shall be indicated on the shop drawing submissions.

E. Provide dedicated 120-volt power circuit(s) from nearby panelboards as required, whether indicated on the plans or not.

2.10 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
   1. Electromagnets: Require no more than 3 W to develop 25-lbf holding force.
   2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
   3. Rating: 24-VAC.
   4. Rating: 120-VAC.

B. Material and Finish: Match door hardware.

2.11 ADDRESSABLE INTERFACE DEVICE

A. General:
   1. Include address-setting means on the module.
   2. Store an internal identifying code for control panel use to identify the module type.
   3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.
   1. Allow the control panel to switch the relay contacts on command.
   2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Addressable Relay Module:
   1. Provide two isolated sets of Form-C contacts, which operate as a double pole double throw switch. The module shall allow the control panel to switch these contacts on command. The module shall not provide supervision for the notification appliance circuit (NAC). Module shall have both normally open and normally closed connections available for field wiring.
   2. Available for HVAC control and other building functions. Relay shall have 2 Form C sets of contacts that operate in tandem and are rated for a minimum of 2.0 amps resistive or 1.0 amps inductive. Relay coil shall be magnetically latched to reduce wiring connection requirements and to ensure 100 percent of all auxiliary relay or NACs shall be energized at same time on same pair of wires.
   3. Mount in standard 4-inch square, 2-1/8-inch deep electrical box or to surface-mounted back box.
   4. LEDs: Flash under normal conditions, indicating monitor module is operational and in regular communication with control panel.

E. Control Module:
   1. Operate notification devices.
   2. Operate solenoids for use in sprinkler service.
2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from firealarm control unit and automatically capture one telephone line and dial a preset number for a remote central station. When contact is made with central station, signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:
   1. Address of the alarm-initiating device.
   2. Address of the supervisory signal.
   3. Address of the trouble-initiating device.
   4. Loss of ac supply.
   5. Loss of power.
   6. Low battery.
   7. Abnormal test signal.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer’s written requirements.

B. Provide network communications pathway per manufacturer’s written requirements and requirements in NFPA 72 and NFPA 70.

C. Provide integration gateway using BACnet for connection to building automation system.

2.14 GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
   1. Factory fabricated and furnished by device manufacturer.
   2. Finish: Paint of color to match the protected device.

B. Provide STI Stopper II Cover with integral sounder on all manual pull stations.
PART 3 - PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

C. Manual Fire-Alarm Boxes:

1. Manual Fire-Alarm Boxes shall be provided where indicated on Drawings. Each addressable manual box shall incorporate a transmitter and receiver having a unique identification and status reporting capability to the control panel.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
4. Each manual fire-alarm box shall be attached to a SLC and be set to a distinct address and internal identification code, which the control panel shall use to identify the location, status, and type of device.
5. Each manual fire-alarm box shall be labeled in a visible area with its device hardware address utilizing self-laminating, flexible vinyl film, non-smear, machine printed labels.

D. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
F. Each smoke and heat detector shall be attached to a SLC and set to a distinct address and internal identification code, which the control panel shall use to identify the location, status, and type of device.

G. Each smoke and heat detector head shall be labeled in a visible area with its device hardware address utilizing self-laminating, flexible vinyl film, non-smear, machine printed labels.

H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
   1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

I. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.

J. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

K. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

L. Audible Alarm-Indicating Devices: Ceiling mount devices wherever possible. Install speakers on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

M. Visible Alarm-Indicating Devices: Devices shall be either ceiling mounted or wall mounted 84 inches above the floor. Install all devices at the same height in a room unless otherwise indicated.

N. Device Location-Indicating Lights: Locate in public space near the device they monitor.

O. Install a device guard over each device located in Gym.

P. Fire alarm devices shall be installed with tamper resistant screws.

Q. Remote power supplies shall be located in readily accessible areas and shall not be located behind or above transformers or electrical equipment.

3.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer’s instructions.

C. Handling: Protect materials from damage during handling and installation.

3.4 PATHWAYS

A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
   1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. In all open ceiling areas, fire alarm cabling shall be installed in EMT conduit. It shall be the responsibility of the Electrical Contractor to provide and install all conduit systems, standard electrical boxes, and operating power for the fire alarm system as outlined on the Drawings and as required. The Fire Alarm Contractor shall coordinate all requirements with, and provide special back boxes to, the Electrical Contractor prior to installation of conduit.

3.5 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors and access gates.
4. Alarm-initiating connection to elevator recall system and components.
5. Supervisory connections at valve supervisory switches.
7. Data communication circuits for connection to building management system.

C. The Electrical Contractor shall provide 120-volt power as required to the fire alarm system through individual dedicated 20-amp maximum branch circuits. The branch circuit(s) shall not be supplied through ground-fault circuit interrupters or arc-fault circuit interrupters. The fire alarm control panel (FACP), digital communicator (DC), and the signal power expanders (SPX) combine to form the fire alarm control unit. The FACP, DC, and SPX may be fed from one circuit as long as the amperage drawn is within the limitations of a 20-amp circuit.

D. Fire safety control functions include any function that is designed to make the building occupants safer from the impact of fire and smoke during evacuation. These may include fire door hold open/release, coiling fire door release, air handler shutdown, smoke damper or fire/smoke damper control, elevator recall, and automatic door unlocking, including the opening of motorized security gates on alarm. For each controlled device, the contractor providing the device shall wire it internally for fail-safe shutdown and provide a 3-foot coil of cable outside the unit to allow the Fire Alarm Contractor to make final connection to the controlling relay. Each Fire Safety Control Function circuit-controlled device shall be configured such that when the fire alarm system safety control circuit is re-energized, by the fire alarm control panel, the device shall return to normal operation without a need for manual or environmental control system intervention. Line voltage 120-volt fire safety control circuits shall be wired by the Electrical Contractor and shall be standard non-supervised line voltage circuits in conduit, utilizing the type of conductors specified in Division 26.

3.6 IDENTIFICATION

A. Install framed instructions in a location visible from fire-alarm control unit.

B. All junction boxes including the cover are to be painted red in color for identification purposes.

C. All control panels and sub panels shall clearly indicate electrical breaker location, including room number, panel name, and breaker number.

D. Each circuit breaker serving the fire alarm system shall be labeled in red, in a visible area utilizing a self-laminating, flexible vinyl film, non-smear, machine printed label, at the power distribution panel as FIRE ALARM. A breaker panel key shall be stored within the locked cabinet of each fire alarm control unit. The location of all circuit breakers serving the fire alarm control unit shall be posted in the fire alarm control unit cabinets. E. Exposed EMT shall be painted red enamel.

E. Conduit extending out of the top of a wall above an accessible ceiling shall have the first two feet painted red.

F. Analog addressable systems shall utilize a number scheme of D1, D2, D3, etc., for smoke detectors and M1, M2, M3, etc., for addressable modules consisting of manual pull stations, water flow switches, tamper switches and other dry contact devices such as hood extinguishing systems.
3.7 GROUNDING
A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit. Each cabinet shall be grounded securely to the building grounding system.
B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.8 FIELD QUALITY CONTROL
A. Field tests shall be witnessed by authorities having jurisdiction.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed record Drawings and system
data that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
      b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reaccepection" column and list only the installed components.
   3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
D. Reacception Testing: Perform reacception testing to verify the proper operation of added or replaced devices and appliances.
E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.
G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.9 MAINTENANCE SERVICE
A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.10 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software and hardware to latest version. Install and program software and hardware upgrades that become available within fifteen (15) years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

D. Installer shall provide a backup copy of the installed program database on USB drive upon completion of the project.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train a minimum of two (2) Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Training shall be provided at the Owner's facilities to facilitate the Owner's trouble shooting and maintenance of the installed system. Include travel and accommodations costs for Owner's maintenance personnel.

END OF SECTION 28 31 11
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Excavating and backfilling for Divisions 21, 22, 23 and 26 exterior utilities.

B. Related Sections:
   1. Divisions 21, 22, and 23 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

C. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

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

PART 2 - PRODUCTS

A. ACCESSORIES

1. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
b. Yellow: Gas.
c. Orange: Telephone and other communications.
d. Blue: Water systems.
e. Green: Sewer systems.

2. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
b. Yellow: Gas.
c. Orange: Telephone and other communications.
d. Blue: Water systems.
e. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
   a. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.3 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:
   1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.4 STORAGE OF SOIL MATERIALS
   A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
      1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.5 BACKFILL
   A. Place and compact backfill in excavations promptly, but not before completing the following:
      1. Testing and inspecting underground utilities.
      2. Removing trash and debris.
      3. Removing temporary shoring and bracing, and sheeting.

3.6 UTILITY TRENCH BACKFILL
   A. Place backfill on subgrades free of mud.
   B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
   C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section.
   D. Backfill voids with satisfactory soil while removing shoring and bracing.
   E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
      1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
   F. Place and compact final backfill of satisfactory soil to final subgrade elevation.
   G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under slabs.
3.7 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
   1. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.8 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompress.

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

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

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

END OF SECTION 31 20 00
PART 1 - GENERAL

1.01 SCOPE

Furnish all labor, materials, equipment, etc., required to properly provide FULL TREATMENT for effective pre-construction treatment for subterranean termite prevention. Treatment shall require the establishment of complete vertical and horizontal approved chemical barriers between the new construction and termite colonies in the soil. FULL TREATMENT shall treat soil under entire building area of all new construction and for a distance of three feet (3’) outside exterior building line.

1.02 GENERAL

A. Treatment chemical shall be approved by the U.S. Environmental Protection Agency (EPA).

B. Pest Control Operator / Applicator shall be licensed by the Texas Structural Pest Control Board. Contractor shall submit proof of license as part of the submittal package.

C. Guarantee: Provide five-year written guarantee. Guarantee to be renewable at Owner’s option by payment of an annual service fee.

1.03 REGULATIONS

A. Termiticide labels have specific directions about the product’s use. Pest Control Companies must follow these directions and Structural Pest Control Board regulations including 599.3 (a) and (b):

(a) All pesticide applications must be made by using the application rate and methods and by following the precautionary statements on the labeling of the pesticide being used. Treatments using less than label recommended concentrations at higher volume applications are prohibited for preconstruction treatments,

(b) for a full treatment the entire structure shall be treated to provide a continuous horizontal and vertical barrier as described on the pesticide label including the posting of a treatment sticker and the final treatment to be performed within 30 days of notification of completion of landscaping or one year from the date of completion of construction, whichever comes first. Except, when construction has proceeded to the point that all areas cannot be treated before the company providing the treatment is called to perform the job, a partial treatment will be permitted if the owner of the structure or the person in charge of the construction and the certified applicator for the pest control company sign a statement attesting to the conditions, and attach it to the contract with an amended graph showing the exact areas treated and send copies to the owner and to the Structural Pest Control Board within seven (7) days of the application.

B. The Structural Pest Control Board will inspect specific treatments in response to consumer complaints or information that indicates a possible improper treatment. THE PEST CONTROL COMPANY IS REQUIRED TO INFORM THE STRUCTURAL PEST CONTROL BOARD 4-24 HOURS PRIOR TO PERFORMING THE TREATMENT. The prior treatment notification requirement is specific to commercial preconstruction and is not required for single-family dwellings. The Board will also inspect treatments during compliance inspections of pest control company operations and will randomly make inspections of job sites where treatments are in progress. Such on-site inspections typically involve collecting samples of the tank mix and soil samples of treatment sites following application. Questions about termite treatment procedures should be directed to the Structural Pest Control Board office.
PART 2 - PRODUCTS

2.01 TERMITE TREATMENT

A. Materials for fipronil soil pre-treatment shall be TERMIDOR as manufactured by Aventis Environmental Science USA LP or imidacloprid soil pre-treatment, PREMISE as manufactured by Bayer Agricultural. Submit all product data and MSDS sheets along with applicator’s proof of license by TSPCB.

PART 3 - EXECUTION

3.01 APPLICATION

A. Termiticides must be used at the prescribed rate, to protect the structure from termites and to comply with state regulations.

B. Apply in accordance with manufacturer’s written instructions on container. Follow all local, state, and federal guidelines. Treatment shall not be made when soil or fill is wet. Treatment shall be done during initial construction under all new concrete slab areas. After all exterior site work is completed, treatment shall be from the building line to a distance of three feet (3’) around the entire perimeter of all building areas.

C. For Horizontal Chemical Barriers, applications shall be made using a low pressure spray after grading is completed and prior to the pouring of the slab or footing to provide thorough and continuous coverage of the area being treated.

D. For Vertical Chemical Barriers, establish vertical barriers in areas such as around the base of foundations, plumbing lines, backfilled soil against foundation walls and other areas which may warrant more than just a horizontal barrier.

E. APPLICATION RATES: Pesticides used to treat for termites (termiticides) are purchased in concentrate form and diluted for application. To evaluate the treatment process, it is necessary to know:

1) the proper dilution ratio and;

2) the correct volume of that solution to apply in or around various structural elements.

3) Dilution ratios are specified on each termiticide label, and they must be followed. If more than one allowable rate for soil application is given, the pest control operator must use at least the minimum rate shown and may not exceed the maximum rate.

4) Most termiticides require 1-2 gallons of concentrate to make up 100 gallons of solution. However, there are some exceptions; it is important to review the label to know the correct rate.

5) The volume of diluted solution used to treat various structural elements is the same on all termiticide labels:

   a) Fill material to be covered by a slab is treated at a rate of 1 gallon per 10 square feet (soil fill). For coarse fill, use 1.5 gallons per 10 square feet or as specified on the product label.
b) Soil backfill areas next to walls, piers, pipes and under “critical areas” like slab expansion joints are treated with 4 gallons per 10 linear feet per foot of depth. (This includes fill areas inside chimneys and earth-filled porches.)

c) Hollow masonry units receive 2 gallons per 10 linear feet. Though a concrete block wall may have multiple chambers (2 or 3 hole blocks), it is counted as one hollow void when calculating the amount of termiticide needed for treatment. Review specific label requirements for proper mixture rates and application procedures.

3.02 CLEAN UP

A. Upon completion, remove all rubbish caused by work of this section and leave premises clean.

END OF SECTION 31 31 16
SECtION 31 63 29

DRILLED CONCRETE PIERS AND SHAFTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Dry-installed drilled piers.

B. Work included:

1. Furnish all labor and materials required to construct drilled concrete piers complete including layout, excavation of shafts, excavation of belled bottoms, temporary steel casings, fabrication and installation of reinforcing steel, furnishing and placing concrete, setting anchor bolts and removal of spoil.

1.3 UNIT PRICES

A. Unit prices are included in Section 012200 "Unit Prices."

B. Drilled Piers: Actual net volume of drilled piers in place and approved. Actual length, shaft diameter, and bell diameter if applicable, may vary, to coincide with elevations where satisfactory bearing strata are encountered. These dimensions may also vary with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts and bells.

1. Base bids on indicated number of drilled piers and, for each pier, the design length from top elevation to bottom of shaft, extended through the bell, if applicable, and the diameter of shaft and bell.

2. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, testing and inspecting, and other items for complete drilled-pier installation.

C. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed outside dimensions of drilled piers cast against rock. Unit prices for rock excavation include replacement with approved materials.

1.4 ACTION SUBMITTALS FOR REVIEW

A. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
1. Laboratory Test Reports: For evaluation of concrete materials and mixture designs.
2. Indicate amounts of mixing water to be withheld for later addition at Project site.

B. Shop Drawings: Indicate dimensioned plan layout, dowel and anchor bolt setting plans including templates, drilled pier shaft sizes, casing sizes, bell sizes at bottom, top of pier elevation, and details of reinforcing steel.

1.5 INFORMATIONAL SUBMITTALS

A. Product Data: For each type of product indicated.
B. Qualification Data: For qualified Installer, land surveyor, professional engineer, and testing agency.
C. Material Certificates: For the following, from manufacturer:
   1. Cementitious materials.
   2. Admixtures.
   3. Steel reinforcement and accessories.
D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
   1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
E. Field quality-control reports.
F. Other Informational Submittals:
   1. Record drawings at project closeout according to Division 1 Section “Closeout Procedures.”

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.
B. Testing Agency Qualifications: Qualified according to ASTM C 1077, ASTM D 3740, and ASTM E 329 for testing indicated.
C. Drilled-Pier Standard: Comply with ACI 336.1 unless modified in this Section.

1.7 PROJECT CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
   1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.
B. Project-Site Information: A geotechnical report has been prepared for this Project and is included elsewhere in the Project Manual. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

C. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Bar Supports: Furnish spacers to maintain required concrete cover to sides and bottom of excavation.


2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I/II. Supplement with the following:
   a. Fly Ash: ASTM C 618, Class C Class F.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.


1. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.


D. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
3. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
4. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
2.3 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

D. Proportion normal-weight concrete mixture as follows:
   1. Compressive Strength (28 Days): As indicated.
   2. Maximum Water-Cementitious Materials Ratio: 0.50.
   3. Minimum Slump: Capable of maintaining the following slump until completion of placement:
      a. 4 inches for dry, uncased, or permanent-cased drilling method.
      b. 6 inches for temporary-casing drilling method.
      c. 7 inches for slurry displacement method.
   4. Air Content: Do not air entrain concrete.

2.4 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI’s "Manual of Standard Practice."

2.5 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
   2. Do not add water to concrete mix after mixing.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

A. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
1. Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time will be authorized for removal of obstructions.

B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

C. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.

   1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
   2. Remove water from excavated shafts before concreting.
   3. Excavate rock sockets of dimensions indicated.

D. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.

   1. Do not excavate shafts deeper than elevations indicated unless approved by Architect.
   2. Payment for additional authorized excavation will be according to Contract provisions for changes in the Work.

E. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.

   1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.

F. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

   1. Maximum Variation From Vertical: One percent of length.
   2. Maximum Variation From Design Top Elevation: Plus 1 inch to minus 3 inches.
   3. Maximum Out-of-Position: One twenty-fourth of the shaft diameter or 3 inches, whichever is less.
   4. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.
   5. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.

3.3 STEEL REINFORCEMENT

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.
E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner’s independent testing and inspecting agency.

B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.

1. Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.
2. Vibrate top 60 inches of concrete.

C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.

1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.

D. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

E. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

F. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 deg F.

1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit reports during excavation and concrete placement for drilled piers.

B. A drilled pier report will be prepared by the Owner’s testing and inspecting agency for each drilled pier with the following information:
1. Actual top and bottom elevations.
2. Actual drilled-pier diameter at top and bottom.
3. Top of rock elevation.
4. Description of soil materials.
5. Description, location, and dimensions of obstructions.
6. Final top centerline location and deviations from requirements.
7. Variation of shaft from plumb.
8. Shaft excavating method.
9. Design and tested bearing capacity of bottom.
10. Depth of rock socket.
11. Levelness of bottom and adequacy of cleanout.
12. Ground-water conditions and water-infiltration rate, depth, and pumping.
13. Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
14. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
15. Date and time of starting and completing excavation.
17. Condition of reinforcing steel and splices.
19. Concrete placing method, including elevation of consolidation and delays.
21. Concrete volume.
22. Concrete testing results.
23. Remarks, unusual conditions encountered, and deviations from requirements.

C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.

1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities will be determined by testing and inspecting agency. Final evaluations and approval of data will be determined by Architect/Engineer.
   a. Bearing Stratum Tests: Testing agency will take undisturbed hardpan or rock core samples from drilled-pier bottoms and test each sample for compression, moisture content, and density, and will report results and evaluations.

D. Concrete Tests and Inspections: ASTM C 172 except modified for slump to comply with ASTM C 94/C 94M.

1. Slump: ASTM C 143/C 143M; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
2. Concrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F and below and 80 deg F and above, and 1 test for each set of compressive-strength specimens.
3. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
4. Compressive-Strength Tests: ASTM C 39; one set for each drilled pier but not more than one set for each truck load. One specimen will be tested at 7 days, 2 specimens will be tested at 28 days, and 1 specimen will be retained in reserve for later testing if required.
5. If frequency of testing will provide fewer than five strength tests for a given class of concrete, testing will be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
6. If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

8. Report test results in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.

9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

10. Additional Tests: Testing and inspecting agency will make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by Architect.

11. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 31 63 29
PART 1 - GENERAL

1.01 SECTION INCLUDES

A. PVC-coated chain link fencing, gates, and accessories;

1.02 SUBMITTALS

A. Shop Drawings: Indicate materials, dimensions, details, and finish, show locations and installation procedures. Include details of fence and gate joints, attachments, accessories, footings, and clearances.

B. Product Data: Submit manufacturer’s schedules, charts, literature, and illustrations indicating the performance, fabrication procedures, product variations and accessories indicating material compliance and specified options.

C. Samples: Submit color selection of PVC finishes for Architect's selection. If requested, submit samples of materials (i.e., fabric, wires, and accessories).

1.03 QUALITY ASSURANCE

A. Chain link fabric shall have the PVC thermally fused to the galvanized steel core wire. Extruded or bonded and glued chain link fence fabric will not be accepted.

B. Fence framework shall have the PVC thermally fused in compliance with ASTM F1234.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Specifications are based on products of Anchor Fence, Inc., Baltimore, MD, Phone (410) 633-6500, Fax (410) 633-6506.

B. Other manufacturers must have a minimum of five (5) years experience manufacturing chain link fencing and gates meeting or exceeding the following specifications for design, size, gauge, finish of metal parts and fabrication and comply with Division 1 requirements for substitutions in order to be considered.

2.02 CHAIN LINK FENCE MATERIALS

A. Fence Fabric:
   1. PVC coating thermally fused to zinc-coated or zinc-5 percent aluminum-mischmetal alloy-coated steel core wire: ASTM F668 Class 2b, 7 mil thickness thermally fused. Core wire tensile strength 75,000 psi.
   2. Size: Helically wound and woven to height of eight (8) feet with two (2) inch diamond mesh, with core wire diameter of 0.148 inch (9 gauge) and a break load of 1290 IV.
   3. Color: ASTM F934, Architect to select from manufacturer’s range of option.
   4. Selvage of fabric shall be knuckled at top and knuckled at bottom.

B. Fence Framing:
1. Steel pipe - Type 1: ASTM F1083, standard weight schedule 40; minimum yield strength of 25,000 psi; sizes as indicated below. Hot-dipped galvanized with minimum average 1.8 oz/ft² of coated surface area.
   a. Line posts: 1.90 inch o.d. up to 6 feet on center; 2.375 inch o.d. up to 10 feet on center.
   b. Terminal, End, Corner, and Pull posts: 2.375 inch o.d. up to 6 feet on center; 2.975 inch o.d. up to 10 feet on center.
   c. Rails and Braces: 1.660 inch o.d.

2. PVC finish: In accordance with ASTM F1043, apply supplemental color coating of 10 to 15 mils thermally fused PVC in color to match fabric.

C. Fence Accessories:
1. Chain link fence accessories: Provide items required to complete fence system. Galvanize each ferrous metal item and finish to match framing.
2. Post caps: Formed steel, cast malleable iron, or aluminum alloy weather tight closure cap for tubular posts. Provide one cap for each post. (Where top rail is used, provide tops to permit passage of top rail.)
3. Top rail and brace rail ends: Formed steel, malleable or cast iron, for connection of rail and brace to terminal posts.
7. Tension (stretcher) bars: One piece lengths equal to 2 inches less than full height of fabric with a minimum cross-section of 3/16 inch x 3/4 inch or equivalent fiber glass rod. Provide tension (stretcher) bars where chain link fabric meets terminal posts.
8. Tension wire: Thermally fused vinyl applied to metallic coated steel wire, 7 gauge, diameter core wire with tensile strength of 75,000 psi.
9. Truss rods: Steel rods with minimum diameter of 5/16 inch.
10. Nuts and bolts are galvanized but not vinyl coated. Color coat nuts and bolts with PVC touch up paint, provided by manufacturer, to match adjacent finishes.

D. PRIVACT SLATS
1. Flat tubular shape with reinforced legs made of extruded HDPE with ultra violet inhibitors
2. Slat Length: 3-1/2” shorter than the overall height of the fence
3. Wind Load and Privacy Factor: 75%
4. Color: To match fencing

2.03 CHAIN LINK SWING GATES

A. Gate frames: Fabricate chain link swing gates in accordance with ASTM F900 using galvanized steel tubular members, 2 inches square, weighing 2.60 lb/ft. Fusion or stainless steel welded connections forming rigid one-piece unit. Vinyl coated frames thermally fused with 10 to 15 mils of PVC in accordance with ASTM 1043. PVC color to match fence.
B. Chain link fence fabric: PVC thermally fused to metallic coated steel wire, ASTM F668, Class 2b, in color, mesh, and gauge to match fence. Install fabric with hook bolts and tension bars at all four (4) sides. Attach to gate frame at not more than 15 inches on center.

C. Hardware materials: Hot dipped galvanized steel or malleable iron shapes to suit gate size. Field coat moveable parts (i.e. hinges, latch, keeper, and drop bar) with PVC touch up paint, provided by manufacturer, to match adjacent finishes.

D. Hinges: Structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180 degrees inward.

E. Latch: Forked type capable of retaining gate in closed position and have provision for padlock. Latch shall permit operation from either side of gate.

F. Keeper: Provide keeper for each gate leaf over five (5) feet wide. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.

G. Double gates: Provide drop rod to hold inactive leaf. Provide gate stop pipe to engage center drop rod. Provide locking device and padlock eyes as an integral part of latch, requiring one (1) padlock for locking both gate leaves.

H. Gate posts: Steel pipe, ASTM F1083, standard weight schedule 40; minimum yield strength of 25,000 psi, 2.875 inches in diameter. Hot-dipped galvanized with minimum 1.8 oz/ft² of zinc or respective material finished in accordance with ASTM F 1043. PVC color to match fence.

I. Refer to site plan for location and size.

2.04 CONCRETE
A. Concrete for post footings shall have a 28-day compressive strength of 2,500 psi. (17.2 MPa).

PART 3 - EXECUTION

3.01 EXAMINATION
A. Verify areas to receive fencing are completed to final grades and elevations. Ensure property lines and legal boundaries of work are clearly established.

3.02 CHAIN LINK FENCE FRAMING INSTALLATION
A. Install chain link fence in accordance with ASTM F567 and manufacturer's instructions.

B. Locate terminal post at each fence termination and change in horizontal or vertical direction of 30 degrees or more.

C. Space line posts uniformly at 10 feet on center.

D. Concrete fence post footings:
   1. Drill holes in firm, undisturbed or compacted soil. Excavate deeper than specified below as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.
   2. Line posts shall be set in 9 inch minimum diameter concrete piers, with a minimum of 33 inches of post embedment in concrete with an additional 3 inch concrete cover at bottom.
3. All end, corner, and pull posts shall be set in minimum 12 inch minimum diameter concrete piers, with a minimum of 33 inches of post embedment in concrete with an additional 3 inch concrete cover at bottom.

4. Place concrete around posts in a continuous pour.

5. Trowel finish around post. Slope to direct water away from posts.

E. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

F. Bracing: Install horizontal pipe brace at mid-height for fences six (6) and over, on each side of terminal posts. Firmly attach with fittings. Install diagonal truss rods at these points. Adjust truss rod, ensuring posts remain plumb.

G. Tension wire: Provide tension wire at bottom of fabric. Install tension wire before stretching fabric and attach to each post with ties. Secure tension wire to fabric with 12-1/2 gauge hog rings 24 inches on center.

H. Top rail: Install lengths, 21 feet. Connect joints with sleeves for rigid connections for expansion/contraction.

I. Bottom Rails: Install bottom rails between posts with fittings and accessories.

3.03 CHAIN LINK FABRIC INSTALLATION

A. Fabric: Install fabric on security side and attach so that fabric remains in tension after pulling force is released. Leave approximately 2 inches between finish grade and bottom selvage. Attach fabric with wire ties to line posts at 15 inches on center and to rails, braces, and tension wire at 24 inches on center.

B. Tension (stretcher) bars: Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands or clips spaced maximum of 15 inches on center.

C. Install fencing in accordance with CLFMI recommendations and as follows:
   1. Stretch fabric to proper tension between terminal posts and securely fasten to frame. Bottom of fabric shall be held as uniformly as practical to the finished grade.
   2. Fasten chain link fabric to fences and backstops securely to terminal posts with 3/16 inch x 3/4 inch tension bars and 11 gauge tie wires, spacing not to exceed 14 inches apart. Tie fabric to top rail with 9 gauge tie wires, spacing not to exceed 24 inches.
   4. Stretch bottom tension wire taut between terminal posts. Securely anchor to each intermediate post 6 inches above grade and secure to fence fabric with hog rings at 24 inches on center.
   6. Cap top of all fence posts.

3.04 ACCESSORIES

A. Tie wires: Bend ends of wire to minimize hazard to persons and clothing.

B. Fasteners: Install nuts on side of fence opposite fabric side for added security.
3.05 CHAIN LINK SWING GATE POST INSTALLATION
   A. Install gate posts in accordance with manufacturer’s instructions.
   B. Concrete gate post footings:
      1. Drill holes in firm, undisturbed or compacted soil. Excavate deeper than specified below as required for adequate support in soft and loose soils, and for posts with heavy lateral loads.
      2. All gate posts shall be set in minimum 12 inch minimum diameter concrete piers, with a minimum of 33 inches of post embedment in concrete with an additional 3 inch concrete cover at bottom.
      3. Place concrete around posts in a continuous pour.
      4. Trowel finish around post. Slope to direct water away from posts.
   C. Gate posts and hardware: Set keeper, stops, sleeves into concrete. Check each post for vertical and top alignment, and maintain in position during placement and finishing operations.

3.06 GATE INSTALLATION
   A. Install gates plumb, level, and secure for full opening without interference.
   B. Attach hardware by means which will prevent unauthorized removal.
   C. Adjust hardware for smooth operation.
   D. Touch up hardware with PVC touch up paint, provided by manufacturer, to match adjacent finishes.

3.07 CLEANING
   A. Clean up debris and unused material, and remove from the site.

END OF SECTION 32 31 15