IDAHO FALLS POLICE DEPARTMENT HEADQUARTERS & AUXILIARY BUILDING
IDAHO FALLS, ID

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Idaho Falls Police Department
Idaho Falls, ID
Bid Issue

Note: Project Manual covers both buildings unless specifically noted: (Main Bldg.) or (Auxiliary Bldg.)

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

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

2.2 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

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

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

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

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

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

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

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

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

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

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

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 21 05 17

SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of exposed to view walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
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, cast-brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 21 05 18

SECTION 21 05 23 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Iron butterfly valves with indicators.
2. Check valves.
3. Iron OS&Y gate valves.
4. NRS gate valves.
5. Indicator posts.
6. Trim and drain valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.

a. Level 1: HCBZ - Indicator Posts, Gate Valve.
b. Level 1: HLOT - Valves.

1) Level 3: HLUG - Ball Valves, System Control.
2) Level 3: HLXS - Butterfly Valves.
3) Level 3: HMER - Check Valves.
4) Level 3: HMRZ - Gate Valves.

2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.

a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.
2) Check valves.

a) Single check valves.

3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 IRON BUTTERFLY VALVES WITH INDICATORS

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

1. Anvil International, Inc.
2. Fivalco Inc.
3. Globe Fire Sprinkler Corporation.
4. Kennedy Valve; a division of McWane, Inc.
5. NIBCO INC.
6. Tyco Fire & Buildings Products LP.
7. Victaulic Company.

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear or traveling nut.

2.3 CHECK VALVES

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

1. Anvil International, Inc.
2. Fire Protection Products, Inc.
3. Fivalco Inc.
4. Globe Fire Sprinkler Corporation.
5. Kennedy Valve; a division of McWane, Inc.
6. Matco-Norca.
7. Mueller Co.; Water Products Division.
8. NIBCO INC.
9. Reliable Automatic Sprinkler Co., Inc.
10. Shurjoint Piping Products.
11. Tyco Fire & Building Products LP.
12. United Brass Works, Inc.
13. Venus Fire Protection Ltd.
14. Victaulic Company.
15. Viking Corporation.
16. Watts Water Technologies, Inc.
17. Wilson & Cousins Inc.

B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psiga.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.4 IRON OS&Y GATE VALVES

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

1. American Cast Iron Pipe Company; Waterous Company subsidiary.
2. Clow Valve Company; a division of McWane, Inc.
3. Hammond Valve.
4. Kennedy Valve; a division of McWane, Inc.
5. Mueller Co.; Water Products Division.
6. NIBCO INC.
7. Victaulic Company.
8. Watts Water Technologies, Inc.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze.
5. Wedge Seat: Cast or ductile iron, or bronze.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.

2.5 NRS GATE VALVES

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

1. American Cast Iron Pipe Company; Waterous Company subsidiary.
2. Clow Valve Company; a division of McWane, Inc.
3. Kennedy Valve; a division of McWane, Inc.
4. Mueller Co.; Water Products Division.
5. NIBCO INC.
6. Victaulic Company.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron.
5. Wedge Seat: Cast or ductile iron, or bronze.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.

2.6 INDICATOR POSTS

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

1. American Cast Iron Pipe Company; Waterous Company subsidiary.

2. Clow Valve Company; a division of McWane, Inc.
3. Kennedy Valve; a division of McWane, Inc.
4. Mueller Co.; Water Products Division.
5. NIBCO INC.

B. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Base Barrel Material: Cast or ductile iron.
3. Extension Barrel: Cast or ductile iron.
4. Cap: Cast or ductile iron.

2.7 TRIM AND DRAIN VALVES

A. Angle Valves:

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

a. Fire Protection Products, Inc.
b. NIBCO INC.
c. United Brass Works, Inc.

2. Description:

a. Pressure Rating: 175 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

1. Section 21 11 00 "Facility Fire-Suppression Water-Service Piping" for application of valves in fire-suppression water-service piping outside the building.
2. Section 21 12 00 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
3. Section 21 13 13 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. 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. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 21 05 53 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

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

END OF SECTION 21 05 23

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

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Restraint channel bracings.
5. Seismic-restraint accessories.
6. Mechanical anchor bolts.

1.2 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Refer to mechanical or structural general notes.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

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

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.
    h. Vibration Mountings & Controls, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 RESTRAINT CHANNEL BRACINGS

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

1. Cooper B-Line, Inc.

2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.6 SEISMIC-RESTRAINT ACCESSORIES

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

1. Cooper B-Line, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO.

B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

D. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.2 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

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Idaho Falls, ID
Bid Issue
END OF SECTION 21 05 48

SECTION 21 05 53 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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

    a. Brady Corporation.
    b. Brimar Industries, Inc.
    c. Carlton Industries, LP.
    d. Champion America.
    e. Craftmark.
    f. Emedco.
    g. Kolbi Pipe Marker Co.
    h. LEM Products Inc.
    i. Marking Services Inc.
    j. Seton Identification Products.

2. Material and Thickness: Brass, 0.032 inch or anodized aluminum, 0.032-inch-thick, with predrilled holes for attachment hardware.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 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.

5. Fasteners: Stainless-steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

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

    a. Brady Corporation.
    b. Brimar Industries, Inc.
    c. Carlton Industries, LP.
    d. Champion America.
    e. Craftmark.
    f. Emedco.
    g. LEM Products Inc.
    h. Marking Services Inc.
    i. National Marker Company.
    j. Seton Identification Products.
    k. Stranco, Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, with predrilled holes for attachment hardware.

C. Letter Color: Red.

D. Background Color: White.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 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.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

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

    a. ActionCraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
    b. Brady Corporation.
    c. Brimar Industries, Inc.
    d. Carlton Industries, LP.
    e. Champion America.
    f. Craftmark.
    g. Emedco.
    h. Kolbi Pipe Marker Co.
    i. LEM Products Inc.
    j. Marking Services Inc.
    k. Seton Identification Products.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. 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 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 LABEL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install or permanently fasten labels on each major item of mechanical equipment.

D. Locate equipment labels where accessible and visible.

E. Pipe-Label Locations: 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. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit a 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.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

END OF SECTION 21 05 53

SECTION 21 30 00 – FIRE SUPPRESSION SPRINKLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Connections and Fees

B. Firelines, Extensions

C. System Design Requirements per Jurisdictional Authorities

D. Interior and Exterior above Ground Piping

E. Sprinkler System

F. Fire Department Connections

G. All Alarms, Switches and Required Wiring

1.2 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. The 21300 Contractor shall furnish all equipment, materials, tools, labor, engineering, drawings, etc. necessary for a complete sprinkler system ready for operation in accordance with the requirements of the authority having jurisdiction. The purpose of the furnished specifications is to convey to the Contractor the scope of work required, all of which the Contractor is responsible to furnish, install, adjust and make operable. In the event the specification omits any necessary system component as required by the authority having jurisdiction shall not relieve the Contractor of the responsibility of providing such necessity, without additional cost to the Owner. The Contractor shall examine all existing physical conditions which may be material to the performance of his work. No extra payments will be allowed to the Contractor as a result of extra work made necessary by his failure to do so. Any case of error, omission, discrepancy or lack of clarity shall be promptly identified to the Owner’s Representative and Engineer for clarification.

1.3 FIRE LINES

A. The work of this section shall start at the water service entrance termination flange installed inside the building and above the floor by the site utilities contractor.

1.4 CONNECTIONS AND FEES

A. System development charges and/or similar charges, that in principal allow the right to obtain the services from the utility will be arranged and paid for by the Site Utilities Contractor.

B. Tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities Contractor.

C. In the event that the serving utility company installs their own taps, service, meters, etc., all costs imposed by this action shall be paid for by the Site Utilities Contractor. Extensions from termination points to connection with building services and systems will be the responsibility of the 21300 Contractor.

D. Be responsible for all pads, vaults, manholes, manhole covers, valve enclosures, valves, services boxes, and required material, all in conformance with requirements of the serving utility company.

E. Contractor shall coordinate with other trades all interface piping and types of connections to be provided for interface.

F. Permit fees shall be provided in the base bid. The 21300 Contractor shall furnish the Owner with a copy of all official documents and written correspondence associated with permits.

1.5 DEFINITIONS

A. The following are references with definition acronyms used in this section:

1. U.L. – Underwriters Laboratory Listed for Fire Protection Systems
2. F.M. – FM Global or Factory Mutual Research
3. IRI – Industrial Risk Insurors (aka: F.I.A. - Factory Insurance Association)
4. NFPA – National Fire Protection Association
5. Jurisdictional Agencies:
6. Building Department
7. Fire Department or Fire Prevention Bureau or Marshal
8. Insurance Agency, Carrier, and/or Underwriter as defined in Section 1.7
9. Engineer refers to the consulting Mechanical Engineer of record
10. Pipe sized used in this Specification are Nominal Pipe Size (NPS)
11. Other definitions for fire protection systems are listed in NFPA 13
12. Working plans as used in this Section mean those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the authority having jurisdiction
13. Review and Approval will be only for conformance with the design concept of the Project and for compliance with the information given in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of

a separate item as such will not indicate approval of the assembly in which the item functions.

1.6 SYSTEM DESIGN REQUIREMENTS

A. Sprinkler System Requirements:

1. Provide a dry-pipe sprinkler system to protect areas subject to freezing.
2. Provide a wet pipe sprinkler system to protect all other areas of the building.
3. Sprinkler heads shall be centered in ceiling tiles in all finished areas.
4. Provide inspector test valve and piped drain at each riser.
5. When water service is not adequate (pressure or flow), provide electric motor driven pressure booster pump and electric jockey pump as required to achieve adequate pressure and flow throughout the system. Pump control system shall permit monitoring and control from the local control panel and remotely from the fire command center. Coordinate all requirements for fuel storage, engine ventilation, engine cooling, muffler installation and engine exhaust discharge location with General Contractor.

B. Occupancy hazard classifications shall be determined in accordance with NFPA 13 unless higher hazard classifications are indicated on the drawings or required by insurance underwriter or jurisdictional authority.

C. Fire protection shall be designed and installed per NFPA 13, NFPA 14, and International Building Code current published standards and local Jurisdictional Agency requirements. Where a conflict occurs the more stringent standard shall apply.

D. Verify requirements with Jurisdictional authorities, Fire Department or Marshal, or Building Department. Provide system complete, functional and acceptable to Jurisdictions without penalty of any type to the insurance premium rate. Division 21300 Contractor shall coordinate his work with all other sections of these specifications and drawings. No change order will be issued for lack of coordination or lack of verification or requirements of Jurisdictional Authorities.

E. System shall be hydraulically calculated per Jurisdictional Agency Standards.

F. All calculations shall include flow test results. Flow tests shall be performed by this Contractor and submitted to the Fire Department. Prior flow tests on file with jurisdictional agencies may be used in lieu of new flow tests only when previous test has been made within 3 months of project start date.

G. The system shall be designed to account for seasonal changes and for future degradation of the water supply system, using previous seasonal flow tests from the water utility to determine the expected range of pressure fluctuation at the project site.

H. Be responsible for accurate measurements, coordination with other trades, required offsets, scheduling, timely submittals, material delivery, job manning, and conformance to construction schedules.

I. All areas shall be classified in accordance with NFPA 13 with respect to hazard classification and shall have automatic sprinkler systems designed for the appropriate classification.

J. Fire Protection Contractor shall furnish and install all alarm and supervisory switches or devices required for the automatic sprinkler system, fire pump, and jockey pump installed so as to provide an electrically supervised system.

K. The number and location of the fire department connections shall be coordinated with the Architect and local Fire Department. The fire department connections shall be piped directly into the building fire protection loop or standpipe system.

L. Each sprinkler riser control valve shall be equipped with a valve supervisory switch and a waterflow switch on piping down stream of the last control valve. Drain piping for each fire protection riser shall be sized and located to accommodate full flow from the main drawin under normal system pressure.

M. When project is located within a seismic zone which is subject to earthquakes, sprinkler systems shall be protected per NFPA 13 to prevent breakage.

1.7 QUALITY ASSURANCE

A. The firm, company, corporation, or partnership producing and providing the material and labor of this Section shall have at least 3 years experience performing scope of work described and required by these Contract Documents.

B. Codes and Standards:

1. All work shall conform to the requirements of the following NFPA Standards and Recommended Practices as appropriate for the type of service except as specifically noted in each Section:

    a. “Installation of Sprinkler Systems,” NFPA 13
    b. “Installation of Standpipe and Hose Systems,” NFPA 14
    c. “Installation of Fire Pumps,” NFPA 30
    d. “National Electrical Code,” NFPA 70
    e. “National Fire Alarm Code,” NFPA 72
    f. “Inspection, Maintenance and Testing of Water-Based Suppression Systems,” NFPA 25

2. All building construction work shall conform to the International Building Code and International Fire Code.
3. All work shall conform to the federal, state and local regulations governing this installation.
4. Should any conflicts occur between any code or standard, the most stringent requirement(s) shall apply.
5. The Fire Protection Contractor shall be subject to the interpretation of statutory requirements by the local Fire Department. Acceptance of the completed systems by the local Fire Department is required.

1.8 TECHNICAL SUBMITTALS

A. Timely submittals are essential to on-time completion of the project. The Owner will incur no obligation to extend the contract completion date, or to reduce or waive any liquidated damaged due, as a result of the Fire Protection Contractor's failure to provide the specified submittals in a timely and acceptable fashion.

B. The information shown on each technical submittal shall be complete with respect to quantities, dimensions, specified performance and design criteria, products, materials, and similar data to enable the Owner, Engineer and Architect to review the information as required. Only complete submittals will be reviewed. Incomplete submittals will be rejected and returned to the Fire Protection Contractor without being reviewed.

C. Each technical submittal shall include a cover letter providing a description of each variation that the submittal may have from the requirements of the Contract Documents. In addition, the Fire Protection Contractor shall provide specific notation on each Working Plan, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.

D. No construction or installation will be authorized until the required submittals are received and reviewed by the Owner, Engineer, and Architect. Any construction or installation performed without written authorization from the Owner shall be entirely at the Fire Protection Contractor's own risk.

E. The required Technical Submittals for all systems and equipment installed in accordance with these specifications include:

1. Working Plans, per NFPA 13
2. Water Supply Information, per NFPA 13
3. Hydraulic Calculations, per NFPA 13
4. Operation and Maintenance Manual
5. Test Protocols
6. Fire Protection Contractor's Material & Test Certificates for Aboveground Piping and for Underground Piping, per NFPA 13
7. Record Drawings

F. Working Plans for sprinkler systems shall be complete and in full accordance with NFPA 13 Chapter on Plans and Calculations.

1. All drawings and calculations shall be reviewed and accepted by the jurisdictional fire department, building department fire marshal, as applicable, and the insurance carrier or insurance reviewing authority prior to submitting to the Engineer. Indication of review and acceptance by all agencies, as appropriate, shall be certified by name or reviewer, agency, and date affixed to the plans or reproducible submitted to the Engineer. None will be accepted or reviewed until compliance with these terms has been established.

G. Operation and Maintenance Manuals shall be prepared specifically for this project and bound in an indexed 3-ring binder, containing:

1. A detailed description of routine maintenance and testing as required and recommended and as would be provided under a maintenance contract, including a testing and maintenance schedule and detailed testing and maintenance instructions for each type of device installed. This description shall include:

    a. A listing of the individual system components that require periodic testing and maintenance.
    b. Step-by-step instructions detailing the requisite testing and maintenance procedures and the intervals at which those procedures should be performed, for each type of device installed. These instructions shall include copies of NFPA 25 – Inspection, Testing and Maintenance of Water-Based Fire Protection Systems and NFPA 72 – National Fire Alarm Code.

2. A schedule, which correlates the step-by-step testing and maintenance procedures with the listing of individual components. This schedule shall be completed for the duration of the warranty prior or for one complete testing/maintenance cycle whichever is longer.
3. A service directory, including installing company's name and telephone numbers for whoever should be called to obtain both normal warranty service and 24-hour emergency service.
4. Drawings and diagrams, as required.
5. System Calculations.
6. Test reports for system, flow rates, and residual pressures.
7. Certified pump curves (all pumps).
8. Wiring diagrams for all system devices.

H. Upon completion of the installation, submit Record Drawings and Contractor's Material & Test Certificates for Aboveground Piping and for Underground Piping, per NFPA 13.

I. Record Drawings shall include all variations from the approved Working Plans, for whatever reason, including those occasioned by modifications, change orders, optional materials and/or required coordination between trades. Variations shall be indicated in sufficient detail to accurately reflect the as-built conditions. Upon completion of the work, before final acceptance, the Fire Protection Contractor shall deliver to the Owner, two (2) additional full-size sets of blue lines, and one (1) set of reproducible record drawings.

1.9 PROJECT CONDITIONS

A. Contractor shall not install any piping until he has assured himself that the piping can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

1.10 WARRANTIES

A. Provide original copies of all warranties and extended warranties for specific equipment.

2.1 PRODUCT LISTINGS AND APPROVALS

A. All system components for which UL listings categories exist shall be listed by Underwriters Laboratories (UL) or Factory Mutual Research (FM).

1. All components shall be listed in the current edition of the UL Fire Protection Equipment Directory. Components shall be delivered to the project site with factory applied UL stickers.
2. Components for which UL listing approvals are “pending” are not acceptable.

B. All system components shall be used in accordance with the manufacturer’s recommendations and their listing.

C. All system components are subject to the approval of the Engineer with regard to their fitness for the intended application.

2.2 INTERIOR AND EXTERIOR ABOVE-GROUND PIPING

A. Pipe and Joints:

1. Black steel and galvanized steel threaded or roll grooved schedule 40 conforming to ASTM A-135 or A-53. Light wall conforming to ASTM A-135 or ASTM A-795. All pipe shall conform to NFPA 13 and Jurisdictional Authorities and Insurance Agency. Where required to meet insurance agency or jurisdictional requirements, all dry pipe system and drain piping shall be galvanized.

B. Fittings:

1. Threaded cast iron, pressure class in accordance with developed system pressures, conforming to ASME B16.4. Threaded malleable iron, pressure class in accordance with developed system pressures, conforming to ASME B16.3.
2. Weld type fitting: Buttweld conforming to ASME B16.9. Flanges conforming to ASME B16.25. Socket weld conforming to ASME B16.11. All welds by certified welder in accordance with Section 15 05 0.
3. Grooved fittings shall conform to ASTM-A47 (malleable), ASTM 536 (ductile), or ASTM-106 GRB (forged steel), ASTM A-53 type E, F, or S GRB (nipples), ASME B16.5 or B16.1 cast iron and carbon steel flanges.

C. Valves:

1. All valves are to be indicating type.
2. All valves U.L. listed, F.M. approved.

D. Hangers:

1. All hangers, attachments and components U.L. listed, F.M. approved.

2. All piping hangers shall conform to Jurisdictional Authorities requirements.
3. Powder driven studs shall not be included in normal installation. Permission to use this type anchoring system must be accepted by the Structural Engineer prior to submitting pricing or bids to any contractor or agent relative to this project.

2.3 SPRINKLER SYSTEM

A. Acceptable Manufacturers: The following manufacturers are acceptable, providing the product to be considered is equivalent in every respect to the nomenclature, style, material, finish, and color provided by the specified make and model.

1. Sprinkler Heads, Alarm, Dry and Deluge Valves, Accelerators, Detector Check Valves, Water Motor Gongs, Air Maintenance Devices, Sprinkler Emergency Cabinets, and Specialties; Automatic, Central, Grinnell, Gem, Reliable, Viking, Notifier, Victaulic, Croker, Potter, Elkhart, Star.

B. Sprinkler Heads:

1. Heads shall be U.L. Listed and of the type required to properly protect the intended space. Heads shall be of ordinary-temperature classification except as required by ceiling temperature, location, or service as allowed or required by code. Escutcheons shall be part of the U.L. Listed sprinkler assembly.

2. Use sprinkler types for the following applications:

a. Rooms without Ceilings: Upright sprinklers.
b. Rooms with Suspended Ceilings: Concealed pendent sprinklers with cover plate.
c. Wall Mounting: Flat plate concealed horizontal sidewall sprinklers.
d. Spaces Subject to Freezing: Sidewall, dry sprinklers

C. Sprinkler Head Cabinets:

1. Steel with red enamel finish for 12 heads complete with appropriate heads, wrench and mounting.

D. Sprinkler Head Guard:

1. Steel wire cage, chrome finish.

2.4 FIRE DEPARTMENT CONNECTION – INLET (SIAMESE)

A. Cast brass, single clapper, straight or angle style as indicated. Provide Siamese connections of sized, styles and patterns required, caps and chains, and wall plate.

B. Style: Flush.

C. Finish: Cast Brass.

PART 3 - EXECUTION

3.1 PREPARATION

A. Field Measurements: Verify all dimensions before proceeding with the work. Obtain field measurements for work required to be accurately fitted to other construction. Be responsible for the accuracy of such measurements and precise fitting and assembly of finished work. Prefabrication of systems is done at this Contractor's own risk.

B. Coordination: Coordinate all work and placement of components with other trades, thorough coordination of design and field installation is expected. Remedial field work may be required to eliminate conflicts and provide an acceptable finished product.

3.2 EXCAVATION, BACKFILL, CUTS AND RESTORATION

A. Cuts – Restoration:

1. All concrete, asphalt, or other hard permanent surface shall be saw cut. Turf areas shall be cut clean with straight edge.
2. Restore all planted, paved, and surfaced areas to original color, texture and condition, replanting where necessary and left in the same or better condition as was found existing.

3.3 INSTALLATION

A. General: Provide a complete operable system designed and installed in accordance with applicable local, state, federal and jurisdictional codes, enforcements agencies and insurance rating or underwriting agencies.

B. All systems shall be drainable with proper drawings devices and drain terminations either to exterior of building or to proper receptacles within building.

C. All systems shall be supported and braced for conformance to proper and applicable standards.

D. Care shall be taken with chrome plated or other polished finished components so that marring does not occur to the finish, and installation provides for a uniform pattern and true installation.

E. Where piping passes thru masonry units or concrete walls or floor or other building construction, sleeves may be used. Where exposed piping passes thru finished work, chrome plated, or other finish acceptable to Architect, split wall plates or escutcheons shall be installed to fit snuggly around piping. Where rated walls are penetrated, approved safing shall be provided at each hole to assure effectiveness of construction as a fire stop.

F. All openings for piping should be anticipated and coordinated with General Contractor. Indicate such openings on the shop drawings. Any additional cutting of openings must be coordinated with the General Contractor.

G. Contractor shall complete the automatic fire sprinkler ready for operation, in all respects, as soon as possible. When system is complete and ready for continuous operation, activate the system for its intended use. After system has been activated for continuous use, water charges, if any will be paid for by the Owner.

H. Use no face bushings.

I. Furnish and install all wiring for all flow switches, tamper switches, exterior and interior alarm items furnished in this Section.

J. Provide seismic restraints in accordance with Jurisdictional Agencies.

K. The sprinkler piping shall be concealed from view in all common and public areas with a finished ceiling. Exposed piping shall be cleaned and left ready for painting by others.

L. Provide seismic separation assembly in accordance with NFPA 13 where pipes cross building seismic separation joints or expansion joints.

3.4 PERFORMANCE

A. General: Systems shall be engineered and designed for proper densities, ease of maintenance and accessibility. Final main drain flow tests shall be made to prove system design and installation.

3.5 CLEANING

A. General: Flush all systems free of all debris and certify system clean and ready for use.

END OF SECTION 21 30 00

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

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

1.2 DEFINITIONS

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

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

1.3 SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE AND COORDINATION

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 Plumbing 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.

D. Division 22 contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with contractors of other divisions of the work whose work is in the same space and shall advise the general contractor of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

E. Division 22 contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. If required for better accessibility, furnish access doors for this purpose. Minor deviations from drawings may be allowed to provide for better accessibility. Any changes shall be approved by the general contractor prior to making the change.

F. Division 22 contractor shall provide the Construction Manager/General Contractor with the exact locations of access doors for each concealed valve, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

G. Prior to purchasing, installing, and/or fabricating any equipment, piping, or ductwork; the division 22 contractor shall assure himself that they can be installed as contemplated in cooperation with contractors of other divisions of the work and the physical constraints of the structural and architectural work.

PART 2 - PRODUCTS

2.1 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.

2.2 JOINING MATERIALS

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

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inchmaximum thickness unless thickness or specific material is indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

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

E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 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-psigminimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150-psigminimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psigminimum working pressure at 225 deg F.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psigminimum working pressure at 225 deg F.

2.4 MECHANICAL SLEEVE SEALS

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

B. Sealing Elements: EPDM. Interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Plastic. Include two for each sealing element.

D. 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.

2.5 SLEEVES

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

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

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

1. Underdeck Clamp: Clamping ring with set screws.

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: Rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Rough brass.

2.7 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

3.1 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.

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

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.

3.2 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

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 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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. 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.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

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

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. 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.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 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. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 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 plumbing 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.

3.5 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.

3.6 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.

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing 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.

3.8 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

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SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

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, provide products by one of the following:

1. Ashcroft Inc.
2. Ernst Flow Industries.
3. Marsh Bellofram.
4. Miljoco Corporation.
5. Nanmac Corporation.
6. Noshok.
7. Palmer Wahl Instrumentation Group.
8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.
10. Trerice, H. O. Co.

11. Watts; a Watts Water Technologies company.
12. Weiss Instruments, Inc.
13. Weksler Glass Thermometer Corp.
14. WIKA Instrument Corporation.
15. Winters Instruments – U.S.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

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. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

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

    a. Trerice, H. O. Co.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7-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.
7. Window: Glass or plastic.
8. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inch, with ASME B1.1 screw threads.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

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

    a. Ernst Flow Industries.
    b. Marsh Bellofram.
    c. Miljoco Corporation.
    d. Palmer Wahl Instrumentation Group.
    e. REOTEMP Instrument Corporation.
    f. Watts; a Watts Water Technologies company.
    g. Weiss Instruments, Inc.
    h. Weksler Glass Thermometer Corp.
    i. WIKA Instrument Corporation.

2. Standard: ASME B40.200.
3. Case: Plastic; 7-inch nominal size.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F.
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.

9. Connector: 1-1/4 inch, with ASME B1.1 screw threads.
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:

1. Standard: ASME B40.200.
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 or CSA.
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, Metal-Case, Dial-Type Pressure Gages:

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

    a. Ametek U.S. Gauge.
    b. Ashcroft Inc.
    c. Ernst Flow Industries.
    d. Flo Fab Inc.
    e. Marsh Bellofram.
    f. Miljoco Corporation.
    g. Noshok.
    h. Palmer Wahl Instrumentation Group.
    i. REOTEMP Instrument Corporation.
    j. Tel-Tru Manufacturing Company.
    k. Trerice, H. O. Co.
    l. Watts; a Watts Water Technologies company.
    m. Weiss Instruments, Inc.
    n. Weksler glass Thermometer Corp.
    o. WIKA Instrument Corporation.
    p. Winters Instruments – U.S.

2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 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.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:

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

    a. Ametek U.S. Gauge.
    b. Ashcroft Inc.
    c. Flo Fab Inc.
    d. Marsh Bellofram.
    e. Miljoco Corporation.

f. Noshok.
g. Palmer Wahl Instrumentation Group.
h. REOTEMP Instrument Corporation.
i. Tel-Tru Manufacturing Company.
j. Trerice, H. O. Co.
k. Weiss Instruments, Inc.
l. Weksler glass Thermometer Corp.
m. WIKA Instrument Corporation.
n. Winters Instruments – U.S.

2. Standard: ASME B40.100.
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.
8. Pointer: Dark-colored metal.
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. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlet and outlet of each domestic hot-water storage tank.

K. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

L. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

M. Adjust faces of meters and gages to proper angle for best visibility.

3.2 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Industrial-style, liquid-in-glass type.

B. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:

1. Liquid-filled, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

C. Thermometer stems shall be of length to match thermowell insertion length.

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:

1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:

1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi.

B. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION 22 05 19

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SECTION 22 05 23 - VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. All valves.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 Annex G and NSF 372.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule on drawings.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B16.18 for solder-joint connections.
4. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

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

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

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

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

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

END OF SECTION 22 05 23

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

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.
6. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing 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 capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following: include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

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

2.2 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 THERMAL-HANGER SHIELD INSERTS

A. 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.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

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

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

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

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated 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.

2.5 PIPE POSITIONING SYSTEMS

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

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:

1. Description: Single base unit with integral-strut and pipe clamps to support pipe, for roof installation without membrane penetration.

2. Accessories: Protection pads.

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: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches 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.

E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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

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

J. 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.

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

L. 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.

M. 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 and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. 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.

3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
4. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
5. 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.
6. 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.
7. 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.
8. 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.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
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.

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

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. 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.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

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

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

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

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. 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.

P. Comply with MSS SP-69 for trapeze pipe-hanger 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.

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

END OF SECTION 22 05 29

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SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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

    a. Brady Corporation.
    b. Brimar Industries, Inc.
    c. Carlton Industries, LP.
    d. Champion America.
    e. Craftmark Identification Systems.
    f. Emedco.
    g. Kolbi Pipe Marker Co.
    h. LEM Products Inc.
    i. Marking Services Inc.
    j. Seton Identification Products.

2. Material and Thickness: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: Yellow.
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: 1/4 inch for name of units if viewing distance is less than 24 inches, 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-quarters the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Identification Systems.
6. Emedco.
7. LEM Products Inc.
8. Marking Services Inc.
9. NMC.
10. Seton Identification Products.
11. Stranco, Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: Red.

D. Background Color: White.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 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-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

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

1. Actioncraft Products, Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Identification Systems.
7. Emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Services Inc.
11. Seton Identification Products.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include 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 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

PART 3 - EXECUTION

3.1 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.2 PIPE LABEL INSTALLATION

A. Pipe Label Locations: 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 and on both sides of 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.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Domestic Water Piping

    a. Background: Safety green.
    b. Letter Colors: White.

2. Sanitary Waste and Storm Drainage Piping:

    a. Background Color: Safety black.
    b. Letter Color: White.

END OF SECTION 22 05 53

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic hot-water piping.
2. Domestic recirculating hot-water piping.
3. Domestic cold-water.
4. Sanitary waste piping exposed to freezing conditions.
5. Storm-water piping exposed to freezing conditions.
6. Roof drain piping and bowls.
7. Overflow drain bowls.
8. Supplies and drains for handicap-accessible lavatories and sinks.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and

adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Insulation Table on drawings for where insulating materials shall be applied.

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

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

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

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

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Special-Shaped Insulation: ASTM C 552, Type III.
2. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
3. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

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

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

a. Aeroflex USA, Inc.

b. Armacell LLC.
c. K-Flex USA.

H. Mineral-Fiber, Preformed Pipe Insulation:

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

a. Johns Manville; a Berkshire Hathaway company.
b. Knauf Insulation.
c. Manson Insulation Inc.
d. Owens Corning.

2. Type I, 850 Deg F (454 Deg C) 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.

I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.

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

a. Armacell LLC.
b. Nomaco Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

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

a. Ramco Insulation, Inc.

2.3 ADHESIVES

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

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

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

a. Foster Brand; H. B. Fuller Construction Products.

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

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

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. Foster Brand; H. B. Fuller Construction Products.
d. K-Flex USA.

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

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

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges – Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

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

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges – Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

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

a. Dow Corning Corporation.
b. John Manville; a Berkshire Hathaway company.
c. P.I.C. Plastics, Inc.
d. Speedline Corporation.

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

    a. Foster Brand; H. B. Fuller Construction Products.
    b. Knauf Insulation.
    c. Vimasco Corporation.

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.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

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

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges – Marathon Industries.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. Knauf Insualtion.
    e. Mon-Eco Industries, Inc.
    f. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants for Cellular-Glass Products:

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

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges – Marathon Industries.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. Mon-Eco Industries, Inc.
    e. Pittsburgh Corning Corporation.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

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

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges – Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. Mon-Eco Industries, Inc.

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.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

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

   a. Childers Brand; H. B. Fuller Construction Products.

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: White.

2.6 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

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

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

    a. Johns Manville; a Berkshire Hathaway company.
    b. P.I.C. Plastics, Inc.
    c. Proto Corporation.
    d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

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

    a. Childers Brand; H. B. Fuller Construction Products.
    b. ITW Insulation Systems; Illinois Tool Works, Inc.
    c. RPR Products, Inc.

2. Finish and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
4. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
5. Factory-Fabricated Fitting Covers:

    a. Same material, finish, and thickness as jacket.
    b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    c. Tee covers.
    d. Flange and union covers.
    e. End caps.
    f. Beveled collars.
    g. Valve covers.
    h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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

    a. Avery Dennison Corporation, Specialty Tapes Division.
    b. Compac Corporation.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insualtion.
    e. Venture Tape.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

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

    a. Avery Dennison Corporation, Specialty Tapes Division.
    b. Compac Corporation.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insualtion.
    e. Venture Tape.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

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

    a. Compac Corporation.
    b. Ideal Tape Co., Inc., an American Biltrite Company.
    c. Venture Tape.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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

a. Avery Dennison Corporation, Specialty Tapes Division.
b. Compac Corporation.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insualtion.
e. Venture Tape.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

PART 3 - EXECUTION

3.1 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.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of 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 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. 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.
4. Cleanouts.

3.3 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 Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. 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.

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

E. 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 Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.4 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. 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.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of 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 services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

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 cut sections of cellular-glass block insulation of same thickness as pipe 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. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. 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.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

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 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

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. Instead, 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 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 polyolefin 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 polyolefin 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 cut sections of polyolefin pipe and sheet insulation to valve body.
2. 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.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. 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 o.c. and at end joints.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Refer to Insulation Table on design drawings for insulation thicknesses.

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.

C. All insulation thicknesses shall meet, as a minimum, International Energy Conservation Code requirements.

END OF SECTION 22 07 19

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SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Piping joining materials.
3. Transition fittings.
4. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.3 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in piping material table located on design drawings.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

C. Comply with NSF Standard 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

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

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

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

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

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

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:

1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
2. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:

1. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
2. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

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

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.5 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, provide products by one of the following:

    a. A. Y. McDonald Mfg. Co.
    b. Capitol Manufacturing Company.
    c. Central Plastics Company.
    d. H A R T Industrial Unions, LLC.
    e. Jomar Valve.
    f. Matco-Norca.
    g. Watts; a Watts Water Technologies company.
    h. Wilkins.
    i. Zurn Industries, LLC.

2. Standard: ASSE 1079.
3. Pressure Rating: 150 psig.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Matco-Norca.
    d. Watts; a Watts Water Technologies company.
    e. Wilkins.
    f. Zurn Industries, LLC.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 150 psig.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3.1 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

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

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance.

D. Install shutoff valve immediately upstream of each dielectric fitting.

E. Install water-pressure-reducing valves downstream from shutoff valves.

F. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

H. Install seismic restraints on piping.

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

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

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

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

P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump.

R. Install thermostats in hot-water circulation piping.

S. Install thermometers on inlet and outlet piping from each water heater.

T. Install sleeves for piping penetrations of walls, ceilings, and floors.

U. Install sleeve seals for piping penetrations of concrete walls and slabs.

V. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

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

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

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

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

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

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

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet 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.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

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

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

D. 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.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

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

F. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

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

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

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

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components.

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

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

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm 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. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

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

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Piping listed in the piping material table on the design drawings to comply with the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
3. Hard or soft copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
4. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

END OF SECTION 22 11 16

SECTION 22 11 17 - PEX-A DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. PEX-a pipe and fittings for domestic water piping.

1.2 RELATED SECTIONS

A. Section 22 11 16 – Domestic Water Piping.

1.3 REFERENCES

A. ASTM International (ASTM):

1. ASTM D 2765 - Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics.
2. ASTM D 6394 - Specification for Sulfone Plastics (SP).
3. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
4. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
5. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
6. ASTM F 876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
7. ASTM F 877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems.
8. ASTM F 1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) Tubing.

B. American Water Works Association:

1. AWWA C904 Standard for Crosslinked Polyethylene (PEX) Pressure Pipe, 1/2 in. Through 2 in., for Water Service.

C. American National Standards Institute (ANSI)/National Sanitation Foundation (NSF)

1. ANSI/NSF Standard 14 Plastics Piping System Components and Related Materials.
2. ANSI/NSF Standard 61 Drinking Water System Components - Health Effects.
3. ANSI/NSF Standard 359 Valves for Crosslinked Polyethylene (PEX) Water Distribution Tubing Systems.

D. American National Standards Institute (ANSI)/Underwriters Laboratories, Inc. (UL)

1. ANSI/UL 263 Standard for Safety for Fire Tests of Building Construction and Materials.
2. ANSI/UL 2846 Standard for Fire Test of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics.

E. American Society of Mechanical Engineers (ASME):

1. ASME B 16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

F. International Code Council (ICC)

1. International Plumbing Code (IPC)

G. International Association of Plumbing Officials (IAPMO)

1. Uniform Plumbing Code (UPC)

H. National Association of Plumbing, Heating and Cooling Contractors (NAPHCC)

1. National Standard Plumbing Code (NSPC)

I. Plastics Pipe Institute (PPI)

1. PPI Technical Report TR-4/06

J. Underwriters Laboratories (UL):

1. UL 2846 Standard for Fire Tests of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics.

K. Field quality-control reports.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Provide manufacturer's product submittal data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall have demonstrated experience on projects of similar size and complexity with documentation proving successful completion of plumbing system installation and/or training by the PEX tubing manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

1. Store PEX tubing in cartons or under cover to avoid dirt or foreign material from entering the tubing.
2. Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, cover the tubing to prevent exposure to direct sunlight.

1.7 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: PEX-a manufacturer system warranty shall cover piping and fittings for a duration of 25 years from the date of installation. Piping system warranty shall apply to potable water distribution and water service systems constructed of pipe and fitting products sourced from the same manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Uponor or Rehau

B. Substitutions: Not permitted.

2.2 PEX PIPE AND FITTINGS

A. PEX-a (Engel-Method Crosslinked Polyethylene) Piping: ASTM F 876 and F877 (CAN/CSA-B137.5) by Uponor.

B. PEX-a Fittings: elbows, adapters, couplings, plugs, tees and multi-port tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:

1. UNS No. C69300 Lead-free (LF) Brass.
2. 20% glass-filled polysulfone as specified in ASTM D 6394.
3. Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D 6394.
4. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D 6394.
5. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D 6394.

6. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".

C. Pre-Sleeved Piping (1/2-inch through 3/4-inch nominal pipe size): PEX-a piping, with a high-density polyethylene (HDPE) corrugated sleeve.

D. Pre-Insulated Piping (1/2-inch through 2-inch nominal pipe size): PEX-a piping, with a closed-cell polyethylene foam insulation.

E. Multi-Port Tees: Multiple-outlet fitting complying with ASTM F 877; with ASTM F 1960 inlets and outlets.

1. Engineered polymer commercial branch multi-port tee.
2. Engineered polymer commercial branch multi-port elbow.
3. Engineered polymer commercial flow-through multi-port tee.

F. Manifolds: Multiple-outlet assembly complying with ASTM F 877; with ASTM F 1960 outlets.

1. Engineered polymer valved manifold.
2. Lead-free copper valved manifold.

2.3 TRANSITION FITTINGS

A. PEX-to-Metal Transition Fittings:

1. Manufacturers: Provide fittings from the same manufacturer of the piping.
2. Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
3. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
4. PEX-a to Flange Transition: two-piece brass fitting with lead-free ProPEX adapter and steel flange conforming to ASME B 16.5.

2.4 VALVES

A. PEX-to-PEX, Lead Free (LF) Brass Ball Valves (1/2-inch through 2-inch nominal pipe size)

1. Manufacturers: Provide ball valve(s) from the same manufacturer as the piping system.
2. Full-port ball valve: two-piece, ASTM F1960 cold-expansion ends, with PEX-a reinforcing cold-expansion ring.
3. LF brass valve with a positive stop shoulder manufactured from C69300 brass.
4. In compliance with: 250 CWP, ANSI/NSF 359, ANSI/NSF 14/61, cNSF-us-pw_G lead free 0.25% Lead max., ASTM F1960, ASTM F 877.

3.1 EXAMINATION

A. Site Verification of Conditions: Verify that site conditions are acceptable for installation of the domestic water piping. Do not proceed with installation until unacceptable conditions are corrected.

3.2 INSTALLATION

A. Install plumbing system according to approved shop drawings and coordination drawings.

B. Comply with manufacturer's product data, including product technical bulletins, installation instructions and design drawings, including the following.

C. Piping Installation:

1. PEX shall not be installed in areas within five feet of UV light.
2. Install piping, piping supports, arms and offsets in compliance with manufacturer's Plumbing Installation Guide.

D. Hangers and Supports:

1. Horizontal PEX-a Piping Hangers: Install CTS hangers suitable for PEX-a piping in compliance with manufacturer recommendations and local codes, with the following maximum spacing:

    a. For IPC Jurisdictions: 2 inch and below: Maximum span, 32 inches.
    b. For UPC Jurisdictions:1 inch and below: Maximum span, 32 inches.
    c. For UPC Jurisdictions: 1-1/4 inch and above: Maximum span, 48 inches.
    d. Note: The above maximum hanger spacing requirements may be extended with the use of a continuous support channel such as Uponor PEX-a Pipe Support.

2. Horizontal PEX-a Piping with PEX-a Pipe Channel: Install hangers for PEX-a piping with horizontal support channel in accordance with local jurisdiction and manufacturer's recommendations, with the following maximum spacing:

    a. 3/4-inch and below: Maximum span, 6 feet.
    b. 1-inch and above: Maximum span, 8 feet.

3. Vertical PEX-a Piping: Support PEX-a piping with maximum spacing of 5 feet.
4. PEX-a Riser Supports: Install CTS riser clamps at the base of each floor and at the top of every other floor for domestic hot-water systems. Install mid-story guides between each floor. Install CTS riser clamps at the base of each floor and at the top of every fourth floor for domestic cold-water systems. Install mid-story guides.

E. Piping Schedule:

1. Underground / under-building slab, domestic water piping (2 inch and below) shall be the following:

   a. 1/2-inch through 2-inch - PEX-a piping with engineered polymer (EP) or lead-free brass F1960 cold-expansion fittings. Insulate in compliance with “Plumbing Piping Insulation” specification. Use the fewest possible joints and install per manufacturer's recommendations.
   b. 1/2-inch through 2-inch - Pre-insulated PEX-a piping with PEX-foam insulation with engineered polymer (EP) or lead-free brass ASTM F 1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer's recommendations.
   c. 3/4-inch through 2-inch - Pre-insulated PEX-a piping with multi-layer, closed-closed cell PEX-foam insulation and a corrugated HDPE jacket with engineered polymer (EP) or lead-free brass ASTM F 1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer's recommendations.

2. In-slab, domestic water piping (2-inch and below) shall be the following: pre-insulated PEX-a piping with engineered polymer (EP) or lead-free brass F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer's recommendations.
3. Aboveground domestic water piping (2-inch and below) shall be the following: PEX-a piping, with engineered polymer (EP) or lead-free brass F1960 cold-expansion fittings. Provide with PEX-a Pipe Channel or thermal expansion loops or thermal expansion bends per manufacturer recommendations for thermal expansion.

F. Pipe Joint Construction: PEX-a Connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for ASTM F 1960 connections.

G. Field Quality Control: Do not expose PEX piping to direct sunlight for more than 30 days. If construction delays are encountered, provide cover to portions of piping exposed to direct sunlight.

END OF SECTION 22 11 17

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water-hammer arresters.
11. Trap-seal primer valves.

B. Related Requirements:

1. Section 22 05 19 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14. Mark "NSF-pw" on plastic piping components.

2.2 PERFORMANCE REQUIREMENTS

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

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Standard: ASSE 1012.
2. Operation: Continuous-pressure applications.
3. Size: NPS 3/4.
4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
5. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
5. Configuration: Designed for horizontal, straight-through flow.
6. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

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

    a. Cash Acme.
    b. Conbraco Industries, Inc.
    c. Honeywell Water Controls.
    d. Watts; a Watts Water Technologies company.
    e. Zurn Industries, LLC.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. Valves for Booster Heater Water Supply: Include integral bypass.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.6 BALANCING VALVES

A. Memory-Stop Balancing Valves:

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

    a. Conbraco Industries, Inc.
    b. Crane; Crane Energy Flow Solutions.
    c. Hammond Valve.
    d. Jenkins Valves; Crane Energy Flow Solutions.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Red-White Valve Corporation.
    h. Stockham; Crane Energy Flow Solutions.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

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

    a. Armstrong International, Inc.
    b. Cash Acme.
    c. Conbraco Industries, Inc.
    d. Honeywell Water Controls.
    e. Legend Valve & Fitting, Inc.
    f. Leonard Valve Company.
    g. Powers.
    h. Symmons Industries, Inc.
    i. TACO Incorporated.
    j. Watts; a Watts Water Technologies company.
    k. Zurn Industries, LLC

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated.

B. Primary, Thermostatic, Water Mixing Valves:

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

    a. Armstrong International, Inc.
    b. Lawler Manufacturing Company, Inc.
    c. Leonard Valve Company.
    d. Powers.
    e. Symmons Industries, Inc.
    f. Zurn Industries, LLC

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psigminimum unless otherwise indicated.
4. Type: Cabinet-type, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated.
9. Piping Finish: Chrome plated.
10. Cabinet: Factory fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.033 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.10 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.9 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.

14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Vacuum Breaker Wall Hydrants:

1. Standard: ASSE 1019, Type A or Type B.
2. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
3. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
4. Pressure Rating: 125 psig.
5. Operation: Loose key.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: NPS 1/2 or NPS 3/4.
8. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.12 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

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

    a. AMTROL, Inc.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Precision Plumbing Products.
    e. Sioux Chief Manufacturing Company, Inc.
    f. Smith, Jay R. Mfg. Co.
    g. Tyler Pipe; a subsidiary of McWane Inc.
    h. Watts; a Watts Water Technologies company.

i. Zurn Industries, LLC

2. Standard: ASSE 1010 or PDI-WH 201.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.13 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

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

   a. MIFAB, Inc.
   b. Precision Plumbing Products.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Com.
   e. Watts; a Watts Water Technologies company.
   f. Zurn Industries, LLC.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

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

   a. Smith, Jay R. Mfg. Co.

2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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. Locate backflow preventers in same room as connected equipment or system.
2. 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 unacceptable for this application.

3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units surface mounted on wall as specified.

E. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

F. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.

G. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.

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

I. 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.

J. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check, backflow-prevention assembly, and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 22 11 19

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SECTION 22 11 23 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 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.

B. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 SUBMITTALS

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

B. Welding certificates.

C. Field quality-control reports.

D. Operation and maintenance data.

1.4 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.

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.

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

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, provide products by one of the following:

a. OmegaFlex, Inc.
b. Parker Hannifin Corporation; Parflex Division.
c. Titeflex.
d. Tru-Flex Metal Hose Corp.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
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 A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet shall be threaded 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.

4. Transition Service-Line Risers: Factory fabricated and leak tested.

    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 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.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
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 2and smaller.
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 2and 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.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
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 2shall have initials "WOG" permanently marked on valve body.

2.5 EARTHQUAKE VALVES

A. Earthquake Valves, Maximum Operating Pressure of 5 psig Comply with ASCE 25.

1. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
2. Maximum Operating Pressure: 5 psig.
3. Cast-aluminum body with nickel-plated chrome steel internal parts.
4. Nitrile-rubber valve washer.
5. Sight windows for visual indication of valve position.

6. Threaded end connections complying with ASME B1.20.1.
7. Wall mounting bracket with bubble level indicator.

2.6 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 2and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
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.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

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.

3.1 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and 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. Install fittings for changes in direction and branch connections.

E. 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.

F. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

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

3.2 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and 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. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2and smaller, adjacent to each valve, at final connection to each piece of equipment.

S. Do not use natural-gas piping as grounding electrode.

T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

U. 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."

V. 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."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.3 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.4 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:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

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. 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.

3.5 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1and 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.

3.6 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.

3.7 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.

3.8 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be one of the following:

1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.

B. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.10 INDOOR PIPING SCHEDULE

A. Aboveground, piping NPS 2and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping NPS 2 and larger and all piping located in return air plenum shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

END OF SECTION 23 11 23

SECTION 22 13 16 - SANITARY WASTE AND VENT AND STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Soil, waste, and vent and storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF/ANSI 14, “Plastics Piping Systems Components and Related Materials,” for plastic piping components. Include marking with “NSF-dwv” for plastic drain, waste, and vent piping and “NSF-sewer” for plastic sewer piping.

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.

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

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

B. Gaskets: ASTM C 564, rubber.

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

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

B. CISPI, Hubless-Piping Couplings:

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

a. ANACO-Husky.
b. Dallas Specialty & Mfg. Co.
c. Fernco Inc.
d. Matco-Norca, Inc.
e. MIFAB, Inc.
f. Mission Rubber Company; a division of MCP Industries, Inc.
g. Ideal Tridon.
h. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

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

a. ANACO-Husky.
b. Clamp-All Corp.
c. Dallas Specialty & Mfg. Co.
d. MIFAB, Inc.

e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Ideal Tridon.
g. Tyler Pipe.

2. Standards: ASTM C 1277 and 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 COPPER TUBE AND FITTINGS

A. Copper Type 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.

2.5 ABS PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.

C. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

D. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

E. Solvent Cement: ASTM D 2235.

2.6 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

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

        1) Dallas Specialty & Mfg. Co.
        2) Fernco Inc.
        3) Mission Rubber Company; a division of MCP Industries, Inc.
        4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

    b. Standard: ASTM C 1173.
    c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    d. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        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, provide products by one of the following:

        1) Cascade Waterworks Mfg. Co.
        2) Mission Rubber Company; a division of MCP Industries, Inc.

    b. Standard: ASTM C 1460.
    c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.2 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 at indicated slopes.

F. Install piping free of sags and bends.

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

H. Install piping to allow application of insulation.

I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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 waste piping in direction of flow is prohibited.

K. Lay buried building waste 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 and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping.
2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

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."

N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

O. Install aboveground ABS piping according to ASTM D 2661.

P. Install aboveground PVC piping according to ASTM D 2665.

Q. Install underground ABS and PVC piping according to ASTM D 2321.

R. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
3. Install drains in sanitary waste gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

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

T. Install sleeves for piping penetrations of walls, ceilings, and floors.

U. Install sleeve seals for piping penetrations of concrete walls and slabs.

V. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

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

C. 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.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

E. Plastic, Nonpressure-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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.

3.5 VALVE INSTALLATION

A. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install 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.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

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

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

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

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

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

H. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

I. Install supports for vertical ABS and PVC piping every 48 inches.

J. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 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 waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste 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 waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Equipment: Connect waste 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.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

3.9 FIELD QUALITY CONTROL

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

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

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

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

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste 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 waste 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

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

B. Protect sanitary waste and vent piping 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.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

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

B. Piping listed in table on design drawings to comply with the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI/ heavy duty hubless-piping couplings; and coupled joints.
3. Copper Type DWV tube, copper drainage fittings, and soldered joints for exposed commercial kitchen applications.

END OF SECTION 22 13 16

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Roof flashing assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

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

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted access check valve.

6. End Connections: Hub and spigot or hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

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

   a. Josam Company; Josam Div.
   b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
   c. Watts Drainage Products Inc.
   d. Zurn plumbing Products Group; Specification Drainage Operation.

2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

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

   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe.
   e. Watts Drainage Products Inc.
   f. 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 as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Cast-Iron Floor Cleanouts:

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

a. Josam Company; Josam Div.
b. Oatey.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Zurn Plumbing Products Group; Light Commercial Operation.
h. Zurn plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing.
5. Body or Ferrule: Cast iron.
6. Outlet Connection: Threaded.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

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

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure Plug: Countersunk or raised head, drilled-and-threaded plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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

a. Commerical Enameling Co.
b. Josam Company; Josam Div.
c. MIFAB, Inc.
d. Prier Products, Inc.
e. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products Inc.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.
3. Body Material: Gray iron.
4. Outlet: Bottom.
5. Top Shape: Round.
6. Top Loading Classification: Medium Duty.
7. Trap Pattern: Deep-seal P-trap.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.

2. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 10 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

a. Open-Top Vent Cap: Without cap.
b. Low-Silhouette Vent Cap: With vandal-proof vent cap.
c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 MISCELLANEOUS SANITARY 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.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

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

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

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

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. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 inches or less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 inches: Equivalent to 1 percent slope.
    c. Radius, 60 inches or larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

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 roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 62 00, Sheet Metal Flashing and Trim.

G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 62 00, Sheet Metal Flashing and Trim.

H. Assemble open drain fittings and install with top of hub 1 inch above floor.

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

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

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

M. Install vent caps on each vent pipe passing through roof.

N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

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

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

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 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 23 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.
5. Trench drains.
6. Flashing materials.

1.2 ACTION SUBMITTALS

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

1.3 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, Large-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron.
3. Dimension of Body: Nominal 14-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Outlet: Bottom.
6. Dome Material: Aluminum.

B. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron.
3. Dimension of Body: 8- to 12-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Outlet: Bottom.
6. Dome Material: Aluminum.

C. Cast-Iron, Small-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron.
3. Dimension of Body: Nominal 8-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Outlet: Bottom.
6. Dome Material: Cast iron.

D. Metal, Cornice and Gutter Roof Drains:

1. Standard: ASME A112.6.4, for cornice and gutter roof drains.
2. Body Material: Metal.
3. Dimension of Body: Nominal 6-inch diameter.
4. Outlet: Bottom.
5. Dome Material: Bronze.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor Nozzles:

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

2.3 CLEANOUTS

A. Floor Cleanouts:

1. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
2. Size: Same as connected branch.
3. Type: Adjustable housing.
4. Body or Ferrule Material: Cast iron.
5. Adjustable Housing Material: Cast iron with set-screws or another device.
6. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
7. Frame and Cover Shape: Round.
8. Top-Loading Classification: Medium Duty.

9. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to clean out.

B. Wall Cleanouts:

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch as required to match connected piping.
4. Closure: Countersunk or raised-head plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.4 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 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.

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. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 12 inches above grade. Secure to building wall.

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

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions 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 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate cleanouts at base of each vertical soil and waste stack.

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

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

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install test tees in vertical conductors and near floor.

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

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

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

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." 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

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SECTION 22 14 29 - SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible sump pumps.
2. Sump-pump basins and basin covers.

1.2 ACTION SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

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

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

a. Barnes: Crane Pumps & Systems.
b. Bell & Gossett Domestic Pump; ITT Corporation.
c. Flo Fab inc.
d. Glentronics, Inc.
e. Goulds Pumps; ITT Corporation.
f. Frundfos Pumps Corp.

g. Liberty Pumps.
h. Little Giant Pump Co.
i. McDonald, A. Y. Mfg. Co.
j. Pentair Pump Group; Hydromatic Pumps.
k. Pentair Pump Group; Myers.
l. Stancor, Inc.
m. Sta-Rite Industries, Inc.
n. Weil Pump Company, Inc.
o. Weinman Division; Crane Pumps & Systems.
p. Zoeller Company.

2. Description: Factory-assembled and -tested sump-pump unit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron, design for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
9. Controls:

    a. Enclosure: NEMA 250.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

10. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

2.2 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Fiberglass.
2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

2.3 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.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 31 20 00 "Earth Moving."

3.2 INSTALLATION

A. Pump Installation Standard: Comply with HI 1.4 for installation of sump pumps.

END OF SECTION 22 14 29

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SECTION 22 34 00 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial, gas-fired, storage, domestic-water heaters.
2. Domestic-water heater accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated.

B. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.

B. Product certificates.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

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

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion.

a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: One year(s).

b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Power-Burner, Gas-Fired, Storage, Domestic-Water Heaters:

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

    a. Aldrich Company, Inc. (The).
    b. Bock Water Heaters, Inc.
    c. Lochinvar, LLC.
    d. Precision Boilers, LLC.
    e. PVI Industries, LLC.
    f. RECO USA.
    g. Rheem Manufacturing Company.
    h. Smith, A. O. Corporation.
    i. State Industries.

2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Storage-Tank Construction: ASME-code steel with 150-psig working-pressure rating.

    a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

        1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
        2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

    b. Interior Finish: Comply with NSF 61 Annex barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

4. Factory-Installed Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
    d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
    e. Jacket: Steel with enameled finish.
    f. Burner: UL 795 for power-burner, gas-fired, domestic-water heaters and natural-gas fuel.
    g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
    h. Temperature Control: Adjustable thermostat.
    i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
    j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

5. Special Requirements: NSF 5 construction.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

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

   a. AMTROL, Inc.
   b. Flexcon Industries.
   c. Honeywell Water Controls.
   d. Pentair Pump Group.
   e. Smith, A. O. Corporation.
   f. State Industries.
   g. Taco, Inc.

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:

   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

F. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.

G. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

H. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

I. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

J. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.

L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.

4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping."

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 22 11 23 "Facility Natural-Gas Piping."

D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for

hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

H. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

I. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

J. Fill domestic-water heaters with water.

K. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 22 11 23 "Facility Natural-Gas Piping."

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

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform 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 operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION 22 34 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Faucets.
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. Fixture supports.
6. Dishwasher air-gap fittings.
7. Disposers.
8. Water closets.
9. Urinals.
10. Lavatories.
11. Bathtubs.
12. Individual showers.
13. Kitchen sinks.
14. Service sinks.

B. Related Sections include the following:

1. Division 22 Section "Drinking Fountains and Water Coolers."

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

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

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

E. PVC: Polyvinyl chloride plastic.

F. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

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

B. LEED Submittal:

1. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.

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

D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

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

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Plastic Laundry Trays: ANSI Z124.6.
3. Plastic Shower Enclosures: ANSI Z124.2.
4. Plastic Sinks: ANSI Z124.6.
5. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
6. Slip-Resistant Bathing Surfaces: ASTM F 462.
7. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
8. Stainless-Steel Residential Sinks: ASME A112.19.3.
9. Vitreous-China Fixtures: ASME A112.19.2M.
10. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
11. Water-Closet, Flushometer Tank Trim: ASSE 1037.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.

3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.
12. Brass Waste Fittings: ASME A112.18.2.

H. Comply with the following applicable standards and other requirements specified for bathtub bathtub/shower and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1.
4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

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

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Dishwasher Air-Gap Fittings: ASSE 1021.
4. Manual-Operation Flushometers: ASSE 1037.
5. Plastic Tubular Fittings: ASTM F 409.
6. Brass Waste Fittings: ASME A112.18.2.
7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Dishwasher Air-Gap Fittings: ASSE 1021.
3. Flexible Water Connectors: ASME A112.18.6.
4. Grab Bars: ASTM F 446.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Hot-Water Dispensers: ASSE 1023 and UL 499.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Toilet Seats: ANSI Z124.5.

10. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. All Plumbing Fixtures:

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

a. American Standard Companies, Inc.
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Eljer.
f. Elkay Manufacturing Co.
g. Jay R. Smith Manufacturing Co.
h. Just Manufacturing Company.
i. Kohler Co.
j. Moen, Inc.
k. Symmons Industries, Inc.
l. T & S Brass and Bronze Works, Inc.
m. Zurn Plumbing Products Group; Commercial Brass Operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install 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 tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

L. Install toilet seats on water closets.

M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

N. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

O. 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.

P. Install shower flow-control fittings with specified maximum flow rates in shower arms.

Q. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

R. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

S. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.

T. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.

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

V. Set bathtubs and showers in leveling bed of cement grout.

W. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 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.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.4 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

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

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

1.2 DEFINITIONS

A. 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, crawlspaces, and tunnels.

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

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

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

1.3 SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE AND COORDINATION

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

B. 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.

C. Division 23 contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with contractors of other divisions of the work whose work is in the same space and shall advise the general contractor of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

D. Division 23 contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. If required for better accessibility, furnish access doors for this purpose. Minor deviations from drawings may be allowed to provide for better accessibility. Any changes shall be approved by the general contractor prior to making the change.

E. Division 23 contractor shall provide the Construction Manager/General Contractor with the exact locations of access doors for each concealed valve, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

F. Prior to purchasing, installing, and/or fabricating any equipment, piping, or ductwork; the division 23 contractor shall assure himself that they can be installed as contemplated in cooperation with contractors of other divisions of the work and the physical constraints of the structural and architectural work.

PART 2 - PRODUCTS

2.1 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.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inchmaximum thickness unless thickness or specific material is indicated.

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

D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

2.3 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-psigminimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150-psigminimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psigminimum working pressure at 225 deg F.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psigminimum working pressure at 225 deg F.

2.4 MECHANICAL SLEEVE SEALS

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

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

C. Pressure Plates: Carbon steel. Include two for each sealing element.

D. 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.

2.5 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.

1. Underdeck Clamp: Clamping ring with set screws.

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: Rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Rough brass.

2.7 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 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. 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.

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

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.

3.2 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.

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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

3.3 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.

3.4 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches 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.

3.5 GROUTING

A. Mix and install grout for HVAC 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 23 05 00

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SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraint channel bracings.
14. Restraint cables.
15. Seismic-restraint accessories.
16. Mechanical anchor bolts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: Refer to General Structural Notes (GSN).
2. Building Classification Category: Refer to General Structural Notes (GSN).
3. Minimum 10 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: Refer to General Structural Notes (GSN).
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: Refer to General Structural Notes (GSN).

    a. Component Importance Factor: Refer to General Structural Notes (GSN).
    b. Component Response Modification Factor: Refer to General Structural Notes (GSN).
    c. Component Amplification Factor: Refer to General Structural Notes (GSN).

3. Design Spectral Response Acceleration at Short Periods (0.2 Second): Refer to General Structural Notes (GSN).
4. Design Spectral Response Acceleration at 1.0-Second Period: Refer to General Structural Notes (GSN).

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

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

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.

c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Waffle pattern.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.

d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

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

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
b. Top housing with attachment and leveling bolt.

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Isolation.
h. Vibration Mountings & Controls, Inc.

2. Housing: Steel housing with vertical limit stops to prevent spring extension due to weight being removed.

a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
b. Top plate with threaded mounting holes.
c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.

6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

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

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.
    h. Vibration Mountings & Controls, Inc.

2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 ELASTOMERIC HANGERS

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

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Isolation Technology, Inc.
d. Kinetics Noise Control, Inc.
e. Mason Industries, Inc.
f. Vibration Eliminator Co., Inc.
g. Vibration Mountings & Controls, Inc.

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

2.12 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

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

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Kinetics Noise Control, Inc.
d. Mason Industries, Inc.
e. Vibration Eliminator Co., Inc.
f. Vibration Isolation.
g. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.13 SNUBBERS

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

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Mountings & Controls, Inc.

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

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

2.14 RESTRAINT CHANNEL BRACINGS

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

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Part of Atkore International.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.15 RESTRAINT CABLES

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

1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.16 SEISMIC-RESTRAINT ACCESSORIES

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

1. B-line, an Eaton business.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.2 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points.

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

D. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet Insert dimension o.c.
3. Brace a change of direction longer than 12 feet.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

K. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 23 21 13 "Hydronic Piping" for piping flexible connections.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

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

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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

    a. Brady Corporation.
    b. Brimar Industries, Inc.
    c. Carlton Industries, LP.
    d. Champion America.
    e. Craftmark Pipe Markers.
    f. emedco.
    g. Kolbi Pipe Marker Co.
    h. LEM Products Inc.
    i. Marking Services, Inc.
    j. Seton Identification Products.

2. Material and Thickness: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: White.
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: 1/4 inch for name of units if viewing distance is less than 24 inches, 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-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

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

    a. Brady Corporation.
    b. Brimar Industries, Inc.
    c. Carlton Industries, LP.
    d. Champion America.
    e. Craftmark Pipe Markers.
    f. emedco.
    g. Kolbi Pipe Marker Co.
    h. LEM Products Inc.
    i. Marking Services, Inc.
    j. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: White.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 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-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. LEM Products Inc.
8. Marking Sevices Inc.
9. National Marker Company.
10. Seton Identification Products.
11. Stranco, Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.

C. Letter Color: White.

D. Background Color: Red.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 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-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

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

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.

5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Sevices Inc.
11. Seton Identification Products.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include 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: Size letters according to ASME A13.1 for piping.

2.4 DUCT LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. Kolbi Pipe Marker Co.
8. LEM Products Inc.
9. Marking Sevices Inc.
10. Seton Identification Products.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.

C. Letter Color: Blue.

D. Background Color: White.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 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-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

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. Pipe Label Locations: 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 and on both sides of 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.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Chilled-Water Piping: White letters on a safety-green background.
2. Condenser-Water Piping: White letters on a safety-green background.
3. Heating Water Piping: White letters on a safety-green background.
4. Refrigerant Piping: White letters on a safety-purple background.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated or self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.
b. Variable-air-volume systems.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: Independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 ACTION SUBMITTALS

1.4 INFORMATIONAL SUBMITTALS

A. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

B. Certified TAB reports.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC, NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC, NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB or TABB as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

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.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units and verify that they are accessible, and their controls are connected and functioning.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. 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. Prepare a TAB plan that includes strategies and step-by-step procedures for balancing the systems.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Duct systems are complete with terminals installed.
b. Volume, smoke, and fire dampers are open and functional.
c. Clean filters are installed.
d. Fans are operating, free of vibration, and rotating in correct direction.
e. Variable-frequency controllers' startup is complete, and safeties are verified.
f. Automatic temperature-control systems are operational.
g. Ceilings are installed.
h. Windows and doors are installed.
i. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE 111 or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," and Section 23 07 19 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts."

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 total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the

terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
    g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
    b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
    b. Re-measure and confirm that total airflow is within design.
    c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
    d. Mark final settings.
    e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
    f. Verify tracking between supply and return fans.

3.7 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.8 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.

3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

3.9 ADDITIONAL TESTS

A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:

    a. Cellular glass.
    b. Flexible elastomeric.
    c. Mineral fiber.
    d. Polyolefin.
    e. Polystyrene.

2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied jackets.
10. Tapes.
11. Securements.
12. Corner angles.

B. Related Sections:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 22 Section "Plumbing Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.
4. Division 33 Section "Underground Hydronic Energy Distribution" for loose-fill pipe insulation in underground piping outside the building.

1.2 SUBMITTALS

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

B. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. 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.

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. 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.

PART 3 - EXECUTION

3.1 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.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, 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, duct system, 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 duct and 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.

3.3 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 Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. 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.

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

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. 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-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. 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. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. 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.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040-inch-thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

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 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range listed in table located on drawings.

3.8 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 23 07 00

SECTION 23 09 23 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Direct digital control (DDC or BMS) system equipment and components for monitoring and controlling of HVAC, exclusive of instrumentation and control devices.

1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.

D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.

J. E/P: Voltage to pneumatic.

K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

L. HLC: Heavy load conditions.

M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

N. I/P: Current to pneumatic.

O. LAN: Local area network.

P. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

Q. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

R. Modbus TCP/IP: An open protocol for exchange of process data.

S. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

T. MTBF: Mean time between failures.

U. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

V. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

W. Peer to Peer: Networking architecture that treats all network stations as equal partners.

X. POT: Portable operator's terminal.

Y. RAM: Random access memory.

Z. RF: Radio frequency.

AA. Router: Device connecting two or more networks at network layer.

BB. Server: Computer used to maintain system configuration, historical and programming database.

CC. TCP/IP: Transport control protocol/Internet protocol.

DD. UPS: Uninterruptible power supply.

EE. USB: Universal Serial Bus.

FF. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

GG. VAV: Variable air volume.

HH. WLED: White light emitting diode.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors effecting performance.
5. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
6. Each submitted piece of product literature to clearly cross reference specification and drawings that submittal is to cover.

B. Shop Drawings:

1. General Requirements:

   a. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.
   b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
   c. Drawings Size: <Insert requirements>.

2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:

   a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork, and piping.
   b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
   c. Each desktop workstation network port, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
   d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
   e. Network communication cable and raceway routing.
   f. Information, drawn to scale, of <Insert requirements>.
   g. Proposed routing of wiring, cabling, conduit, and tubing; coordinated with building services for review before installation.

6. Schematic drawings for each controlled HVAC system indicating the following:

   a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
   b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
   c. A graphic showing location of control I/O in proper relationship to HVAC system.
   d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
   e. Unique identification of each I/O that to be consistently used between different drawings showing same point.
   f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
   g. Narrative sequence of operation.
   h. Graphic sequence of operation, showing all inputs and output logical blocks.

7. Control panel drawings indicating the following:

a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
c. Front, rear, and side elevations and nameplate legend.
d. Unique drawing for each panel.

8. DDC system network riser diagram indicating the following:

a. Each device connected to network with unique identification for each.
b. Interconnection of each different network in DDC system.
c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

9. DDC system electrical power riser diagram indicating the following:

a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
d. Power wiring type and size, race type, and size for each.

10. Monitoring and control signal diagrams indicating the following:

a. Control signal cable and wiring between controllers and I/O.
b. Point-to-point schematic wiring diagrams for each product.
c. Control signal tubing to sensors, switches, and transmitters.
d. Process signal tubing to sensors, switches, and transmitters.
e. Pneumatic main air and control signal tubing to pneumatic [damper] [and] [valve] actuators, pilot-positioners if applicable, and associated transducers.

11. Color graphics indicating the following:

a. Itemized list of color graphic displays to be provided.
b. For each display screen to be provided, a true color copy showing layout of pictures, graphics, and data displayed.
c. Intended operator access between related hierarchical display screens.

C. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.

2. Complete listing and description of each report, log and trend for format and timing, and events that initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:

    a. Loss of power.
    b. Loss of network communication signal.
    c. Loss of controller signals to inputs and outpoints.
    d. Operator workstation failure.
    e. Server failure.
    f. Gateway failure.
    g. Network failure.
    h. Controller failure.
    i. Instrument failure.
    j. Control damper and valve actuator failure.
    k. <Insert potential failure conditions>.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

D. Delegated Design Submittals: For DDC system products and installation indicated as being delegated.

1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Schedule and design calculations for control dampers and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Face velocity at Project design and minimum airflow conditions.
    c. Pressure drop across damper at Project design and minimum airflow conditions.
    d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    e. Maximum close-off pressure.
    f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.
    i. Actuator signal to control damper (on, close, or modulate).
    j. Actuator position on loss of power.
    k. Actuator position on loss of control signal.

3. Schedule and design calculations for control valves and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Pressure-differential drop across valve at Project design flow condition.
    c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.

d. Design and minimum control valve coefficient with corresponding valve position.
e. Maximum close-off pressure.
f. Leakage flow at maximum system pressure differential.
g. Torque required at worst case condition for sizing actuator.
h. Actuator selection indicating torque provided.
i. Actuator signal to control damper (on, close or modulate).
j. Actuator position on loss of power.
k. Actuator position on loss of control signal.

4. Schedule and design calculations for selecting flow instruments.

a. Instrument flow range.
b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter, and output signal for remote control.
c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter, and output signal for remote control.
d. Pressure-differential loss across instrument at Project design flow conditions.
e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to do the following:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and databases on electronic media.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

1.5 QUALITY ASSURANCE

A. Building control system to be Automated Logic and installed by Climatech.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring, and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to <Insert value> force.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 07 84 13 "Penetration Firestopping."

G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 07 92 00 "Joint Sealants."

H. Welding Requirements:

1. Restrict welding and burning to supports and bracing.
2. No equipment is cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
3. Welding, where approved, is to be by inert-gas electric arc process and is to be performed by qualified welders in accordance with applicable welding codes.
4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

I. Fastening Hardware:

1. Wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

K. Corrosive Environments:

1. Avoid or limit use of materials in corrosive airstreams and environments including, but not limited to, the following:

    a. Laboratory exhaust-air streams.
    b. Process exhaust-air streams.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not already corrosive resistant from instrument manufacturer, field install products in NEMA 250, Type 4X instrument enclosure constructed of Type 316L stainless steel.

3.2 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade to provide a fully functioning DDC system. Work is to comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 26 28 16 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.3 INSTALLATION OF IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for identification products and installation.

B. Install [self-adhesive labels] [laminated acrylic or melamine plastic signs] with unique identification on face for each of the following:

1. Server.
2. Gateway.
3. Router.
4. DDC controller.
5. Enclosure.
6. Electrical power device.
7. UPS unit.
8. Accessory.

C. Install unique instrument identification for each instrument connected to DDC controller.

D. Install unique identification for each control [damper] [and] [valve] actuator connected to DDC controller.

E. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.

F. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.

G. Warning Labels and Signs:

1. Permanently attach to equipment that can be automatically started by DDC control system.
2. Locate where highly visible near power service entry points.

3.4 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables."
2. Comply with installation requirements in Section 27 13 13 "Communications Copper Backbone Cabling."
3. Comply with installation requirements in Section 27 15 13 "Communications Copper Horizontal Cabling."
4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.

    a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.

5. Terminate wiring in a junction box.

    a. Clamp cable over jacket in a junction box.
    b. Individual conductors in the stripped section of cable is to be slack between the clamping point and terminal block.

6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
7. Install signal transmission components in accordance with IEEE C2, REA Form 511a, NFPA 70, and as indicated.
8. Use shielded cable to transmitters.
9. Use shielded cable to temperature sensors.
10. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section 26 05 33 "Raceway and Boxes for Electrical Systems" for control-voltage conductors.
2. Comply with Section 27 05 28 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.5 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

E. For pneumatic products, verify that air supply for each product is properly installed.

F. Control Damper Checkout:

1. For pneumatic control dampers, verify that pressure gauges are provided in each air line connected to the damper actuator and positioner.
2. Verify that control dampers are installed correctly for flow direction.
3. Verify that proper blade alignment, either parallel or opposed, has been provided.
4. Verify that damper frame attachment is properly secured and sealed.
5. Verify that damper actuator and linkage attachment are secure.
6. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
7. Verify that damper blade travel is unobstructed.

G. Control Valve Checkout:

1. For pneumatic control valves, verify that pressure gauges are provided in each air line connected to the valve actuator and positioner.
2. Verify that control valves are installed correctly for flow direction.
3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment are secure.
5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
6. Verify that valve ball, disc, or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments, verify the following:

    a. Sensing element type and proper material.
    b. Length and insertion.

3.6 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION, AND TESTING

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

1. Use field testing and diagnostic instruments and equipment with an accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.

F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.

G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.

H. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated.

I. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

J. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

K. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.

2. Stroke pneumatic control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with cycle time less than [30] <Insert number> seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

L. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke pneumatic control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with cycle time less than [30] <Insert number> seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Meters: Check meters at zero, 50, and 100 percent of Project design values.

N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

O. Switches: Calibrate switches to make or break contact at set points indicated.

P. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.7 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase, and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to backup power source.
6. If applicable, verify that power conditioning units are installed.

B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.8 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify that operation is stable and accurate.
4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:

    a. Upper quarter of range.
    b. Lower quarter of range.
    c. At midpoint of range.

8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller, and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller, and at field instrument must match.
10. Prepare and submit report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.9 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After [review] [approval] of Pretest Checklist and Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed Pretest Checklist.

D. Pretest Checklist: Submit the following list with items checked off once verified:

1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. HVAC equipment motors operate below full-load amperage ratings.
4. Required DDC system components, wiring, and accessories are installed.
5. Installed DDC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.
7. Required surge protection is installed.

8. DDC system network communications function properly, including uploading and downloading programming changes.
9. Using BACnet protocol analyzer, verify that communications are error free.
10. Each controller's programming is backed up.
11. Equipment, products, tubing, wiring cable, and conduits are properly labeled.
12. All I/O points are programmed into controllers.
13. Testing, adjusting, and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power[and loss of signal].
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power[and loss of signal].
18. Meter, sensor, and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphics are created.
26. Record Drawings are completed.
27. <Insert additional requirements>.

E. Test Plan:

1. Prepare and submit validation Test Plan including test procedures for performance validation tests.
2. Address all specified functions of DDC system and sequences of operation in Test Plan.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include Test Checklist to be used to check and initial that each test has been successfully completed.
6. Submit Test Plan documentation [10] [20] <Insert number> business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.

    a. Verify analog I/O points at operating value.
    b. Make adjustments to out-of-tolerance I/O points.

        1) Identify I/O points for future reference.
        2) Simulate abnormal conditions to demonstrate proper function of safety devices.

3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.

2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. 24 hours after initial validation test, do as follows:

   a. Re-check I/O points that required corrections during initial test.
   b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.

5. 24 Hours after second validation test, do as follows:

   a. Re-check I/O points that required corrections during second test.
   b. Continue validation testing until I/O point is normal on two consecutive tests.

6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit report indicating results of testing. For all I/O points that required correction, indicate how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.

   a. Heavy load to be occurrence of [50] <Insert number> percent of total connected binary COV, one-half of which represents "alarm" condition, and [50] <Insert number> percent of total connected analog COV, one-half of which represents "alarm" condition, that are initiated simultaneously on a one-time basis.

2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:

   a. Reaction to COV and alarm conditions during HLC.
   b. Ability to update DDC system database during HLC.

5. Passing test is contingent on the following:

   a. Alarm reporting at printer beginning no more than [two] <Insert number> seconds after initiation (time zero) of HLC.
   b. All alarms, both binary and analog, are reported and printed; none are lost.
   c. Compliance with response times specified.

6. Prepare and submit report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks are to use more than 70 percent of available bandwidth under normal and HLC operation.

3.10 FINAL REVIEW

A. Submit written request to Architect [Owner] [Commissioning Agent] [and] [Construction Manager] when DDC system is ready for final review. State the following:

1. DDC system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.
5. <Insert additional requirements>.

B. Upon receipt of written request for final review, [Architect] [Owner] [Commissioning Agent] [and] [Construction Manager] to start review within [xx business days] [reasonable period] and upon completion issue field report(s) documenting observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Compensation for Subsequent Reviews: Should more than [two] <Insert number> reviews be required, DDC system manufacturer and Installer to compensate entity/entities performing reviews for total costs (labor and expenses) associated with subsequent reviews. Estimated cost of each subsequent review to be submitted and approved by DDC system manufacturer and Installer before review.

E. Prepare and submit closeout submittals[and begin procedures indicated in "Extended Operation Test" Article] when no deficiencies are reported.

F. Part of DDC system final review shall to include demonstration to parties participating in final review.

1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.

2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
3. Demonstration to include, but not be limited to, the following:

    a. Accuracy and calibration of [10] [20] <Insert number> I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
    b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to [10] [20] <Insert number> I/O points to be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
    c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
    d. Operation of randomly selected dampers and valves in normal-on, normal-off, and failed positions.
    e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
    f. Trends, summaries, logs, and reports set up for Project.
    g. For up to [three] <Insert number> HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
    h. Software's ability to communicate with controllers, operator workstations, and uploading and downloading of control programs.
    i. Software's ability to edit control programs offline.
    j. Data entry to show Project-specific customizing capability including parameter changes.
    k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
    l. Execution of digital and analog commands in graphic mode.
    m. Spreadsheet and curve plot software and its integration with database.
    n. Online user guide and help functions.
    o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
    p. System speed of response compared to requirements indicated.
    q. For Each [Network] [and] [Programmable Application] Controller:

        1) Memory: Programmed data, parameters, trend, and alarm history collected during normal operation are not to be lost during power failure.
        2) Operator Interface: Ability to connect directly to each type of digital controller with portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.

3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
4) Electric Power: Ability to disconnect any controller safely from its power source.
5) Wiring Labels: Match control drawings.
6) Network Communication: Ability to locate controller's location on network and communication architecture matches Shop Drawings.
7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

r. For Each Operator Workstation:

1) I/O points lists agree with naming conventions.
2) Graphics are complete.
3) UPS unit, if applicable, operates.

s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management.[Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability.] Requirements must be met even if only one manufacturer's equipment is installed.

1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
3) Set-Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.[Modifications are made with messages and write services initiated by operator using workstation graphics, or by completing a field in menu with instructional text.]
4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.

9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:

a) Display of network device status.
b) Display of BACnet object information.
c) Silencing devices transmitting erroneous data.
d) Time synchronization.
e) Remote device re-initialization.
f) Backup and restore network device programming and master database(s).
g) Configuration management of routers.

t. <Insert additional requirements>.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

B. Extent of Training:

1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:
   a. Stagger training over multiple training classes to accommodate Owner's requirements. All training to occur before end of warranty period.

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SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.

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. 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.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.4 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.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inchmisalignment in minimum 7-inchlong assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 REFRIGERANTS

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

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Suction Lines NPS 4and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at strainers if they are not an integral part of strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.

G. 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.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. 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.

J. 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. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

L. Install flexible connectors at compressors.

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. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. 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 Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. 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.

O. 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.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

R. 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."

S. 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."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

B. 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.

3.5 HANGERS AND SUPPORTS

A. 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.

B. 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.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

C. Support multifloor vertical runs at least at each floor.

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 and specialties. 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

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SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 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 62.1-2004.

1.3 SUBMITTALS

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

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 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 1-4, "Transverse (Girth) 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 1-5, "Longitudinal Seams - Rectangular Ducts," 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 2, "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 ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. 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.

G. Tie Rods: Galvanized steel, 1/4-inchminimum diameter for lengths 36 inches or less; 3/8-inchminimum 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, provide products by one of 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 Fat 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 NRTL 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-inchgalvanized 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. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. 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.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. 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 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

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 Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "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 4, "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.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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 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 Division 23 Section "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 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.

B. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.

b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

1.2 SUBMITTALS

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

B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60

2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts.

D. 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.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. 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.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Duro Dyne Inc.
5. Greenheck Fan Corporation.
6. Lloyd Industries, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. Pottorff; a division of PCI Industries, Inc.
10. Ruskin Company.
11. SEMCO Incorporated.
12. Vent Products Company, Inc.

B. Description: Gravity balanced.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. Flexmaster U.S.A., Inc.
d. McGill AirFlow LLC.
e. METALAIRE, Inc.

f. Nailor Industries Inc.
g. Pottorff; a division of PCI Industries, Inc.
h. Ruskin Company.
i. Trox USA Inc.
j. Vent Products Company, Inc.

2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.

B. Standard, Aluminum, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. Flexmaster U.S.A., Inc.
d. McGill AirFlow LLC.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Pottorff; a division of PCI Industries, Inc.
h. Ruskin Company.
i. Trox USA Inc.
j. Vent Products Company, Inc.

2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.

2.4 CONTROL DAMPERS

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

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Duro Dyne Inc.
5. Flexmaster U.S.A., Inc.
6. Greenheck Fan Corporation.
7. Lloyd Industries, Inc.
8. M&I Air Systems Engineering; Division of M&I Heat Transfer Products Ltd.
9. McGill AirFlow LLC.
10. METALAIRE, Inc.
11. Metal Form Manufacturing, Inc.
12. Nailor Industries Inc.
13. NCA Manufacturing, Inc.
14. Ruskin Company.
15. Vent Products Company, Inc.
16. Young Regulator Company.

2.5 FIRE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. McGill AirFlow LLC.
6. METALAIRE, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. PHL, Inc.
10. Pottorff; a division of PCI Industries, Inc.
11. Prefco; Perfect Air Control, Inc.
12. Ruskin Company.
13. Vent Products Company, Inc.
14. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wgstatic pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours.

2.6 SMOKE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. PHL, Inc.
6. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

2.7 DUCT-MOUNTED ACCESS DOORS

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

1. American Warming and Ventilating; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Flexmaster U.S.A., Inc.
5. Greenheck Fan Corporation.
6. McGill AirFlow LLC.
7. Nailor Industries Inc.
8. Pottorff; a division of PCI Industries, Inc.
9. Ventfabrics, Inc.
10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inchbutt 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: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
   d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Single wall with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 10-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.8 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 or control 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. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

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 from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible

links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.

7. At each change in direction and at maximum 50-footspacing.
8. Upstream from turning vanes.
9. Control devices requiring inspection.
10. 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 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Install duct test holes where required for testing and balancing purposes.

O. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inchmovement during start and stop of fans.

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. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

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SECTION 23 34 16 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Backward-inclined centrifugal fans.
2. Forward-curved centrifugal fans.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.

B. Field quality-control test reports.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

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

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

PART 2 - PRODUCTS

2.1 BACKWARD-INCLINED CENTRIFUGAL FANS

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

1. Carrier Corporation.
2. Chicago Blower Corporation.
3. Loren Cook Company.
4. Madison Manufacturing.
5. GreenHeck
6. New York Blower Company (The).
7. Trane.

B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Spun inlet cone with flange.
3. Outlet flange.

D. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.

1. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours.
2. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.5.
2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
6. Motor Mount: Adjustable for belt tensioning.

H. Accessories:

1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
2. Scroll Drain Connection: NPS 1steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.

I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.

2.2 FORWARD-CURVED CENTRIFUGAL FANS

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

1. Carrier Corporation.
2. Chicago Blower Corporation.
3. GreenHeck
4. Industrial Air; a division of Lau Industries, Inc.
5. Loren Cook Company.
6. Madison Manufacturing.
7. New Philadelphia Fan Co.
8. New York Blower Company (The).
9. Trane.

B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Spun inlet cone with flange.
3. Outlet flange.

D. Forward-Curved Wheels: Black-enameled or galvanized steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.5.
2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
6. Motor Mount: Adjustable for belt tensioning.

H. Accessories:

1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
2. Scroll Drain Connection: NPS 1steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with 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. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Support floor-mounting units using restrained spring isolators having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by authorities having jurisdiction. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install units with clearances for service and maintenance.

G. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

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. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 23 34 16

SECTION 23 37 13 - AIR DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. All Air Devices

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 Air Devices

A. Refer to drawings for requirements and approved manufacturers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air devices 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 air devices with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust air devices to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

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SECTION 23 54 16 - GAS-FIRED FURNACES (Auxiliary Bldg.)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gas-fired furnaces and accessories.
2. Air filters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Refer to schedules on drawings for requirements.

B. Shop Drawings:

1. Include details of equipment assemblies. 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.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within manufacturer specified warranty period

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended location and application.

3.1 INSTALLATION

A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.

B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

D. Controls: Install thermostats and humidistats at mounting height of 60 inches above floor.

E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

3.2 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.

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

C.

D. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following (refer to equipment schedule for piping material ty:

    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. CPVC Piping: Join according to ASTM D 2846/D 2846M, Appendix.
    c. 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.

4. Slope pipe vent back to furnace or to outside terminal.

E. Connect ducts to furnace with flexible connector.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and test for leaks. Repair leaks, replace lost refrigerant, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

END OF SECTION 23 54 16

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SECTION 23 55 33 - GAS-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes gas-fired unit heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of gas-fired unit heater.

1. Include rated capacities, operating characteristics, and accessories.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Gas-fired unit heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Seismic Fabrication Requirements: Fabricate and reinforce suspension attachments of gas-fired unit heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Section 23 05 48 "Vibration and Seismic Controls for HVAC "Section 15074 "Vibration and Seismic Controls for HVAC" when gas-fired unit heater is anchored to building structure.
2. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

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.

2.2 MANUFACTURED UNITS

A. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.

B. Gas Type: Design burner for natural gas having characteristics same as those of gas available at Project site.

C. Accessories:

1. Four-point suspension kit.
2. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.
3. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes and flashing for wall or roof penetration.

D. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated gas and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written instructions.

3.2 EQUIPMENT MOUNTING

A. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

3.3 CONNECTIONS

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

B. Where installing piping adjacent to gas-fired unit heater, allow space for service and maintenance.

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:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Gas-fired unit heater will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain gas-fired unit heaters.

END OF SECTION 23 55 33

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SECTION 23 72 13 - AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes air-to-air energy recovery units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For air-to-air energy recovery equipment.

1. Include plans, elevations, sections, details, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For air-to-air energy recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 COORDINATION

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

PART 2 - PRODUCTS

2.1 PERFORMANCE 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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE Compliance:

1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat/Energy Exchangers."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Air-to-air energy recovery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 SOURCE QUALITY CONTROL

A. AHRI 1060 Certification: Testing according to AHRI 1060 and listed and labeled by AHRI.

PART 3 - EXECUTION

3.1 INSTALLATION OF HEAT WHEELS

A. Examine roughing-in for electrical services to verify actual locations of connections before installation.

B. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.

1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
3. Access doors and panels are specified in Section 233300 "Air Duct Accessories."

C. Equipment Mounting:

1. Install air-to-air energy recovery equipment on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

D. Install seismic restraints according to manufacturers' written instructions.

E. Install units with clearances for service and maintenance.

F. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

3.2 PIPING CONNECTIONS

A. Condensate Drain Piping: Pipe drains from drain pans to nearest floor drain; use ASTM D1785, Schedule 40 PVC pipe and solvent-welded fittings, same size as condensate drain connection.

B. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 237213

SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS AND VRF

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

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

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

PART 2 - PRODUCTS

2.1 Not Used

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. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

3.2 CONNECTIONS

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

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 23 31 13 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 23 33 00 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. 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.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

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SECTION 26 05 00 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

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

B. Provisions of this Section shall apply to all Sections of Division 26, 27, and 28.

1.2 SCOPE OF WORK

A. Furnish and install all materials and equipment and provide all labor required and necessary to complete the work shown on the drawings and/or specified in all Sections of Division 26 and all other work and miscellaneous items, not specifically mentioned, but reasonably inferred for a complete installation, including all accessories required for testing the system. It is the intent of the drawings and specifications that all systems be complete and ready for operation.

1.3 CODE COMPLIANCE

A. All work and materials shall comply with the latest rules, codes and regulations, including, but not limited to, the following:

1. Occupational Safety and Health Act Standards (OSHA)
2. NFPA #70 – National Electric Code (NEC)
3. ADA Standards – Americans with Disabilities Act
4. ANSI/IEEE C-2 – National Electrical Safety Code
5. NECA – Standard of Installation

B. International Building Code

C. International Fire Code

D. International Energy Conservation Code

E. NFPA #72 – Fire Code

F. NFPA #101 – Life Safety Code

G. All other applicable Federal, State and local laws and regulations.

H. Work to be executed and inspected in accordance with local codes and ordinances. Permits, fees or charges for inspection or other services shall be paid for by the contractor. Local codes and ordinances are to be considered as minimum requirements and must be properly executed without expense to the owner; but do not

relieve the contractor from work shown that exceeds minimum requirements.

1.4 CONDITIONS AT SITE

A. Visit to site is recommended of all bidders prior to submission of bid. All will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.

B. Lines of other service that are damaged as a result of this work shall be promptly repaired at no expense to the owner to the complete satisfaction of the owner.

1.5 DRAWINGS AND SPECIFICATIONS

A. All drawings and all specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.

B. Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduits and wiring is not assured. Exact requirements shall be governed by architectural, structural and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.

C. Change to location, type, function, brand name, finish, etc., shall not be made without permission of engineer.

D. Some equipment is specifically designated on the drawings. It is not the intent to sole source any item unless explicitly stated. Items have been specified based upon design requirements. All bidders are encouraged to submit products for approval. Prior approval must be obtained as required by these contract documents. Bids submitted with non-approved items will be considered invalid and bidders will be held to provide approved materials at no additional cost to the owner. Submittals received by the engineer after award of contract on non-approved equipment will not be reviewed nor will they be returned.

E. Where conflicting direction is given within the specifications and drawings, the contractor shall include the most expensive option in the bid.

1.6 SAFETY AND INDEMNITY

A. Safety: The contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours.

B. No act, service, drawing review or construction review by the owner is intended to include review of the adequacy of the contractor’s safety measures in, on, or near the

construction site.

1.7 CONSTRUCTION OBSERVATION BY THE ENGINEER

A. Prior to covering: any major portion of the materials installed under this section, notify the engineer so that an observation can be made. Notification shall be made at least three (3) working days in advance of the date the items will be covered.

1.8 INSTRUCTION OF OWNER'S PERSONNEL

A. The contractor shall conduct an on-site instructional tour of the entire project. The personnel designated by the owner shall be instructed in: operation of all electrical systems, trouble-shooting procedures, preventative maintenance procedures, uses of Operation and Maintenance manuals, maintenance and cleaning of lighting fixtures and operation of all special systems.

B. Contractor will include in his bid 8 hours of instruction time to be held at the project location after substantial completion for instruction of owner's personnel. Coordinate time and number of owner personnel to be present and provide schedule to engineer.

1.9 PROJECT COMPLETION

A. Upon completion of all work and operational checks on all systems, the contractor shall request that a final construction observation be performed.

B. The engineer shall compile a punch list of items to be completed or corrected. The contractor shall notify the engineer upon completion of the items.

1.10 GUARANTEE

A. All work under this section shall be guaranteed in writing to be free of defective work, materials, or parts for a period of one (1) year after final acceptance of the work under this contract or the period indicated under the Division 1 specifications whichever is longer.

B. Repair, revision or replacement of any and all defects, failure or inoperativeness shall be done by the contractor at no cost to the owner.

PART 2 - PRODUCTS

2.1 MATERIAL APPROVAL

A. The design, manufacturer and testing of electrical equipment and materials shall conform to or exceed latest applicable NEMA, IEEE or ANSI standards.

B. All materials must be new, unless noted otherwise, and UL listed. Materials that are

not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency, which laboratory shall be acceptable to the owner and code enforcing agency.

2.2 SHOP DRAWINGS AND MATERIALS LIST

A. Submit an electronic copy, unless noted otherwise under Division 1, of the Division 26, 27 and 28 shop drawings and material lists proposed for this project to the architect/engineer for review.

2.3 OPERATION AND MAINTENANCE MANUALS

A. Submit an electronic copy, unless noted otherwise under Division 1, of the Operation and Maintenance Manuals for all Division 26, 27 and 28 equipment to the architect/engineer.

2.4 RECORD DRAWINGS

A. Submit record drawings to owner.

2.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials in a manner to prevent damage.

B. Protect equipment from weather and dampness.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

A. Only quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.

B. Provide experienced foreman with a minimum of three years experience working on this type of building placed in charge of this work at all times.

3.2 COORDINATION

A. Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under trades that require electrical connections. Inform contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.

B. Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work. Report necessary

changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without the authorization of the owner, shall be at contractor's risk and expense.

3.3 MANUFACTURER'S INSTRUCTIONS

A. All installations are to be made in accordance with manufacturer's recommendations. A copy of such recommendations shall at all times be kept in the job superintendent's office and shall be available to the engineer.

B. Follow manufacturer's instructions where they cover points not specifically indicated on drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the engineer before starting work.

3.4 QUALITY ASSURANCE

A. The contractor shall insure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

B. Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and special systems.

3.5 CUTTING AND PATCHING

A. Perform all cutting and fittings required for work of this section in rough construction of the building.

B. All patching of finished construction of building shall be performed under the sections of specifications covering these materials.

C. No joists, beams, girders or columns shall be cut by any contractor without obtaining written permission from the architect/engineer.

END OF SECTION 26 05 00

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SECTION 26 05 01 – FIELD TEST AND OPERATIONAL CHECK

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.

B. 260502 - Short-Circuit-Coordination Study-Arc Flash Hazard Analysis

1.2 SCOPE OF WORK

A. Ground resistance test.

B. 600V cable insulation test.

C. Sectionalizing switch insulating oil test.

D. Transformer insulating liquid test.

E. Primary voltage cable high potential test.

F. Main and distribution switchboard and panelboard operational check and test.

G. Generator test.

1.3 GENERAL SCOPE

A. The contractor shall engage and pay for the services of a recognized independent testing laboratory for the purpose of performing inspections and tests as specified in this Section.

B. The testing laboratory shall provide all material, equipment, labor and technical supervision to perform such tests and inspections.

C. These tests shall assure that all electrical equipment is operational within industry and manufacturer’s tolerances, is installed in accordance with design specifications, and shall determine the suitability for energization.

D. The contractor shall schedule the tests and give a minimum of two weeks advance notice to the owner.

1.4 QUALIFICATIONS OF TESTING AGENCY

A. Testing agency shall be Current Technologies Inc. or approved equal.

1.5 TEST INSTRUMENT TRACEABILITY

A. The testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.

B. Instruments shall be calibrated at the following frequency:

C. Field instruments: Six months maximum

1. Laboratory instruments: 12 months
2. Leased specialty equipment: 12 months (where accuracy is guaranteed by lessor, e.g. Doble)

D. Dated calibration levels shall be visible on all test equipment.

1.6 FINAL SETTINGS

A. The contractor shall set the protective devices in accordance with a short-circuit and protective device coordination report.

1.7 TEST REPORT

A. Submit copies of the test results to the owner. Test results shall be included in the project O &M Manuals.

B. The test report shall include a project summary, description of equipment tested, description of test, list of test equipment used and calibration date, test results, conclusions and recommendations, appendix (including appropriate test forms), and standards used.

C. The test report shall be bound and its contents certified.

1.8 FAILURE TO MEET TEST

A. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported directly to the owner.

B. Contractor shall replace the defective material or equipment and have test repeated until test proves satisfactory without additional cost to the owner.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.1 GROUND RESISTANCE TEST

A. Building grounding electrode resistance testing shall be accomplished with a ground resistance direct-reading single test meter utilizing the Fall-of-Potential method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the concrete-encased ground electrode to be tested and the two reference electrodes in a straight line spaced fifty (50) feet apart. Drive the two reference electrodes five (5) feet deep.

B. Test results shall be in writing and shall show temperature, humidity and condition of the soil at the time of the tests. In the case where the ground resistance exceeds five (5) ohms, the owner will issue additional instructions.

3.2 600 VOLT CABLE INSULATION TEST

A. Megger and record insulation resistances of all 600 volt insulated conductors size 4/0 AWG and larger using a 500 volt megger for one minute. Conduct tests with circuits isolated from source and load.

3.3 SECTIONALIZING SWITCH INSULATING OIL TEST

A. Sample test the insulating oil in accordance with ASTM D-923 for the following:

B. Dielectric strength.

1. Acid neutralization number.
2. Interfacial tension.
3. Color.

3.4 PAD MOUNT TRANSFORMER INSULATING LIQUID TEST

A. Sample test the insulating liquid of the pad mount transformer in accordance with ASDM D-923 for the following:

B. Dielectric strength.

1. Acid neutralization number.
2. Interfacial tension.
3. Color.

3.5 MAIN AND DISTRIBUTION SYSTEM SWITCHBOARD AND PANELBOARD OPERATIONAL CHECK AND TEST

A. Check cleanliness of all interiors and all parts. Remove any excess packaging, shipping bolts, etc. Inspect for shipping damage.

B. Tighten all points of connection with torque wrench to values recommended by the manufacturer.

C. Verify proper operating condition of all equipment mechanically and electrically,

including, but not limited to:

D. Wiring for all meters and instrumentation.

1. Verify operation of each circuit breaker trip device with an accurately metered timed instrument (by passing 300 percent rated current through each pole).
2. Verify relay operation by introduction of accurately metered currents into both overcurrent and ground fault circuitry at values which will enable accurate determination of the tripping coordination of main and feeder breakers. Provide this test with the tie breaker when provided.
3. Verify short time pick-up and delay, and instantaneous pick-up current. These should conform with manufacturer's published time current characteristic curves.
4. Auxiliary protective devices such as phase failure relays shall be activated to ensure operation.
5. Determine instantaneous pick-up current by primary injection using run-up or pulse method. Clearing time shall be within four (4) cycles.
6. Perform insulation resistance test per NASET specification section 2.
7. Measure the system neutral to ground resistance with neutral disconnect link removed, for ground fault protected systems.
8. Utilizing primary current injection, verify the breaker picks up and trips within the manufacturer's recommendations.
9. If the ground fault relay is external to the breaker or switch, ensure the operation at reduced voltage (60% for AC control and 80% for DC control).
10. Exercise all devices and components ensuring smooth operation.
11. Devices shall be tested upon settings defined by the breaker coordination study for this project.

E. If any equipment is found defective during operational check, it shall be replaced by the contractor without cost to the owner and tests repeated by the contractor, without cost to the owner, until satisfactory results are obtained.

3.6 PRIMARY VOLTAGE CABLE HIGH POTENTIAL TEST

A. All primary cables shall be given DC high potential tests after installation. All tests shall be performed in the presence of the owner and shall be performed to their complete satisfaction. DC high potential test of cables shall be performed after all splices and cable terminations are made but before connections to equipment are made. A DC micro-ammeter in series with the ground connection of the high voltage transformer shall be used to read the leakage current in the cable at two minute intervals during the test.

B. A variable voltage regulator of adequate rating shall be used to permit the raising of test voltage over a minimum of ten minutes in 5kV increments from zero to final test values as recommended by cable manufacturer. Testing time shall be started when the voltage on the cable has attained final test value and shall be continued for at least ten minutes thereafter.

C. Results of the test shall be plotted, current against voltage at each 5kV increment of rise after two minutes minimum or after value has stabilized, to a maximum test value, and current against time for 10 minutes thereafter in one minute intervals on a separate

sheet for each length of cable tested. Curves shall be identified with the cable to which they apply and shall be certified. Time of day, outside temperature, and humidity at time of each test shall appear on each curve sheet.

D. If any primary cable fails or tests, in the opinion of the owner, show unacceptable cable defects, all cables in that conduit between the nearest pulling points on each side of the failure shall be withdrawn. If, in the opinion of the owner, other cables that may have been installed in the same duct are not damaged, they may be re-installed, but the failed cable shall be replaced with new cable without additional charge.

E. After replacement of the faulty cable, and any other damaged cables, all cables of the circuit in that conduit shall be retested. If the cable fails again, or if tests, in the opinion of the owner, show unacceptable cable defects, all cables shall be replaced without charge and this procedure shall be repeated until tests prove satisfactory.

3.7 GENERATOR TEST

A. After the installation and initial start-up of the engine generator set is complete, a test shall be performed and logged in the presence of the owner. The contractor shall have the engine generator manufacturer furnish and engineer to operate the engine during the test, to check all details of the installation and to instruct the operators. The engineer will be required for a period of not less than two days for instruction and tests and all costs in connection therewith shall be included in the contractor's bid. The contractor shall furnish all fuel, lubricants, load banks and instruments necessary to conduct the tests and shall connect all devices required to obtain data required below. The resistor load bank shall be connected to the load side of the automatic transfer switch and the contractor shall make any necessary temporary connections to obtain full load for the test.

B. On site testing shall include all items specified in NFPA-110.

C. Field test requirements: Data shall be recorded every 15 minutes and at the beginning and end of every separate test and shall include all electrical and temperature information. Testing shall be accomplished in the following sequence:

D. Check all engine and generator mounting bolts. Check alignment of engine generator and realign if not within manufacturer's limits.

1. Test generator and exciter insulation resistance with a megger. Take generator readings at circuit breaker or at leads to switchboards. Record all results in the test report.
2. Perform engine manufacturer's recommended prestarting checks. Include a check of water, fuel, and lube oil levels within the engine.
3. Start engine and make engine manufacturer's after starting checks during a reasonable run-in or warm-up period.
4. Operate engine generator for one hour at 50% of rated load.
5. Operate engine generator for one hour at 75% of rated load.
6. Operate engine generator for two hours at 100% of rated load.
7. Measure sound level to assure that the sound spectrum does not exceed the criteria specified.

8. Increase engine speed by manually overriding the governor. Speed shall be measured by a tachometer. Record speed at which overspeed trip operates.
9. Demonstrate functioning of high temperatures coolant circuit by restricting airflow through the radiator. Record temperatures.
10. Shutdown engine and observe operation of low oil pressure control. Record pressure at which trip operates. Note: If safety conditions of the safety system are not met during any of the preceding three steps, the necessary readjustments shall be made and the step repeated until satisfactory results are obtained.
11. Ensure proper operation of the automatic exercising system by setting system for automatic operation then manually initiating and exercise period of at least 30 minutes.
12. A battery starting test shall be performed with the charger disconnected, consisting of four (4) cranking cycles of 10 seconds “on” and 10 seconds “off.” The engine fuel supply shall be shut off to prevent starting.

E. Checks to be made during on-site testing:

F. Proper operation of all controls.

1. Proper operation of all gauges and instruments throughout operation.
2. Proper operation of all auxiliary and accessory equipment. All valves, including pilot valves and injection pump, shall be checked during the tests to ensure proper operation.

G. Inspection: Upon completion of the on-site tests, a general inspection shall be made for:

H. Leaks in the engine, piping systems, tank, etc.

1. Excessive blow-by.
2. Any other deficiency which may impair proper operation.
3. Change oil and oil filter and record hour readings.

I. Acceptance: Final acceptance shall be made when the generator set has successfully completed the on-site test and after all defects in material or operation have been corrected with maintenance manuals and training completed.

END OF SECTION 26 05 01

SECTION 26 05 02 – SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or a professional licensed engineer. The final report shall be stamped/singed by a professional engineer licensed in the state the project is located.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the current version of NFPA70E.

C. The scope of the studies shall include all distribution equipment supplied under this contract.

1.2 RELATED DOCUMENTS

A. 26 05 01 – Field Test and Operational Check

B. 26 24 13 - Main Switchboards

C. 26 24 16 – Panelboards

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

6. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Five (5) bound copies of the complete final report shall be submitted. For large system studies. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.

B. The report shall include the following sections:

1. Executive Summary
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout

6. Details of the incident energy and flash protection boundary calculations
7. Recommendations for system improvements, where needed
8. One-line diagram
9. Arc flash labels shall be provided in hard copy.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

1.7 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of:

1. SKM Systems Analysis Power*Tools for Windows (PTW) software program
2. Easy Power
3. Or Pre-Approved Software.

PART 2 - PRODUCT

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Tabulations of calculated quantities
6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility’s supply termination point
2. Incoming switchgear
3. Low voltage switchgear
4. Motor control centers
5. Branch circuit panelboards
6. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 75KkVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary

considering an incident energy of 1.2 cal/cm2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Reactor data, including voltage rating, and impedance.
4. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

    a. Voltage
    b. Calculated fault current magnitude and angle
    c. Fault point X/R ratio
    d. Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

    a. Voltage
    b. Calculated symmetrical fault current magnitude and angle
    c. Fault point X/R ratio
    d. Calculated asymmetrical fault currents
        1. Based on fault point X/R ratio
        2. Based on calculated symmetrical value multiplied by 1.6
        3. Based on calculated symmetrical value multiplied by 2.7

    e. Equivalent impedance

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable

location:

a. Voltage
b. Calculated symmetrical fault current magnitude and angle
c. Fault point X/R ratio
d. No AC Decrement (NACD) Ratio
e. Equivalent impedance
f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:

a. Current transformer ratio
b. Current setting
c. Time setting
d. Instantaneous setting
e. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:

a. Adjustable pickups and time delays (long time, short time, ground)
b. Adjustable time-current characteristic
c. Adjustable instantaneous pickup
d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacture or the approved testing agencies listed in the related testing section(s).

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 600, 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided.

F. Labels shall be installed by the engineering service division of the equipment manufacture or the approved testing agencies listed in the related testing section(s).

3.3 ARC FLASH TRAINING

A. The contractor of the Arc Flash Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours).

END OF SECTION 26 05 02

SECTION 26 05 19 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

A. Submit shop drawings and product data.

1.4 COORDINATION

A. Coordinate layout and installation of cables with other installations.

B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by the owner.

PART 2 - PRODUCTS

2.1 BUILDING WIRES AND CABLES

A. Conductors: Stranded, copper, 600 volt insulation, type THHN/THWN, THHN/THWN-2, XHHN/XHHW.

B. Conductors:

C. Solid or stranded for No. 10 and smaller, stranded for No. 8 and larger, copper, 600 volt insulation, type THHN/THWN. Aluminum conductors not allowed unless noted otherwise.

1. Insulation Types: THWN-2 for underground, THWN for wet locations, THHN for dry locations; XHHN/XHHW for GFI branch circuits and feeders fed from GFCI breakers.

D. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Black.
2. Phase B: Red.
3. Phase C: Blue.
4. Neutral: White.
5. Ground: Green.
6. Isolated ground: Green with yellow tracer.

E. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Brown.
2. Phase B: Orange.
3. Phase C: Yellow.
4. Neutral: White or gray.
5. Ground: Green.

F. Wire connectors and splices: units of size, ampacity rating, material, type and class suitable for service indicated.

G. Signal and communication circuits:

1. Special cables as indicated on the drawings.
2. Conductors for general use: stranded copper conductor, #16 AWG minimum, with THWN-2 insulation for underground, THWN for wet locations and THHN insulation for dry locations.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Use no wire smaller than #12 AWG for power and lighting circuits and no smaller than #18 AWG for control wiring.

C. The contractor is responsible for upsizing conductor sizes to ensure the maximum voltage drop of any branch circuit does not exceed 3%. For reference, use No. 10 AWG conductor for 20 Amp, 120 volt branch circuits longer than 75 feet, and for 20 Amp, 277 volt branch circuits longer than 200 feet.

D. Place an equal number of conductors for each phase of a circuit in the same raceway or conduit.

E. Splice only in junction or outlet boxes.

F. Neatly train or lace wiring inside boxes, equipment, and panelboards.

G. Make conductor lengths for parallel circuits equal.

H. Provide a separate neutral conductor for each ungrounded conductor. Ungrounded conductors may share a neutral when all of the following conditions are met:

I. The ungrounded conductors are connected to a multi-pole breaker or breakers that are clipped together with a UL listed means that provide a common trip.

J. The ungrounded conductors contained in the same conduit or raceway.

K. The ungrounded conductors all originate from a separate and unique phase bus in the panel.

3.2 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions, and the “National Electrical Installation Standards" by NECA.

B. Remove existing wires from raceway before pulling in new wires and cables.

C. Pull Conductors: 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.

D. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables above accessible ceilings; do not rest on ceiling tiles. Do not fasten cables to ceiling support wires. Use cable ties to support cables from structure.

3.3 CONNECTIONS

A. Conductor Splices: Keep to minimum.

B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

C. Use splice and tap connectors compatible with conductor material.

D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

G. Terminate spare conductors with electrical tape.

3.4 LABELING

A. Provide Brady wire markers or equivalent on all conductors. All wire shall be labeled in each box and panel with the circuit number and panel identification.

3.5 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage.

B. Perform continuity testing on all power and equipment branch circuit conductors. Verify proper phasing connections.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Fixed Price Construction Contract and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to concrete encased electrode, metal underground water pipe, and effectively grounded metal frame of building.

B. Ground each separately-derived system neutral to nearest effectively grounded metal structural frame of building or point of service entrance ground.

C. Provide communications system grounding conductor to point of service entrance ground.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle ground connectors, and plumbing systems.

1.4 QUALITY ASSURANCE

A. Testing: Refer to Section 26 05 01 – Field Test and Operational Check.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Section 260519 - Conductors and Cables.

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation. Where green insulation is not available, on larger sizes, black insulation shall be used and suitably identified with green tape at each junction box or device enclosure.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow tracer. Where not available, green and yellow tape at each junction box or device enclosure.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Medium hard drawn copper conductor, stranded, sized as shown on the drawings.

G. Hardware: Bolts, nuts and washers shall be bronze; cadmium plated steel or other non-corrosive material, approved for the purpose.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.2 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

D. Below grade compression fittings: Thomas & Betts, Series 52000, 53000, and 54000 or equivalent.

E. Use connector and sealant approved for purpose on all below grade clamp or compression type connections.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, 5/8 inch diameter, minimum length 8 feet.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.

F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NEC Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NEC are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways bonded to outlet or equipment, sized per Section 250 of the NEC.

G. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on grounding bar.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

H. Provide green insulated ground conductor to exterior post light standards.

I. Provide grounding and bonding at pad-mounted transformer in accordance with Section 261200.

3.3 INSTALLATION

A. Ground Rods: Where indicated, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, unless otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. UFER Ground (Concrete-Encased Grounding Electrode): Fabricate according to NEC 250, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized.

Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 SYSTEM NEUTRAL GROUND

A. Ground the neutral conductor of each transformer or generator to limit the maximum potential above ground due to normal operating voltage and limit the voltage level due to abnormal conditions.

B. Ground generators or transformers with secondary voltage 600 volt or less as follows:

C. 3 phase, 4 wire Wye connected: ground neutral point

D. For transformers 75 kVA or smaller with primary voltage 480 volt or less the primary equipment ground conductor may be used for grounding the secondary neutral provided it is adequately sized in accordance with NEC system ground conductor size.

3.6 EQUIPMENT GROUND

A. Ground non-current carrying metal parts of electrical equipment enclosures, frames, conductor raceways or cable trays to provide a low impedance path for line-to-ground fault current and to bond all non-current carrying metal parts together. Install a grounding conductor in each raceway system. Equipment grounding conductor shall be electrically and mechanically continuous from the electrical circuit source to the equipment to be grounded. Size grounding conductors per NEC 250 unless otherwise shown on the drawings.

B. Install metal raceway couplings, fittings, and terminations secure and tight to ensure good grounding continuity. Provide grounding conductor sized per NEC through all raceway and conduit systems.

C. Lighting fixtures shall be securely connected to equipment grounding conductors. Outdoor lighting standards shall have a factory installed ground lug for terminating the grounding conductor.

D. Motors shall be connected to equipment ground conductors with a bolted solderless lug connection on the metal frame.

3.7 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Test ground system per Section 26 05 01.

END OF SECTION 26 05 26

SECTION 26 05 33 - RACEWAYS AND BOXES

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RMC: Rigid metal conduit.

F. RNC: Rigid Polyvinyl Chloride conduit.

G. PVC: Rigid Polyvinyl Chloride conduit

H. HDPE: High Density Polyethylene Conduit

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. IMC: ANSI C80.6.

C. PVC coated Steel Conduit and Fittings: NEMA RN 1; rigid steel conduit with external 40 mil PVC coating and internal two mil urethane coating.

D. EMT and Fittings: ANSI C80.3. Fittings: Set-screw type.

E. FMC: Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.2 NONMETALLIC CONDUIT AND TUBING

A. RNC: NEMA TC 2, Schedule 40 PVC. Fittings: NEMA TC 3; match to conduit and material.

2.3 METAL WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. 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.

C. Finish: Manufacturer's standard enamel finish.

2.4 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.

2.5 FLOOR BOXES

A. Floor Boxes: Cast metal, fully adjustable, rectangular, unless otherwise specified.

2.6 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.7 ENCLOSURES AND CABINETS

A. Hinged-Cover Enclosures: NEMA 250, Type 1, 3R, or 4, with continuous hinge cover and flush latch, key operable.

B. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

C. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.8 J-HOOKS

A. J-hooks: Steel, rated for indoor use in non-corrosive environments. J-hooks shall be rated to support Category 5e cable.

B. Fittings and Support Bodies: Manufacturer’s recommended fittings including side mount flange clips, bottom mount flange clips, beam clamp, rod and flange clip, C & Z purlin clip, and all other components and assemblies to make the system work.

C. Acceptable Product: Caddy CableCat Hanging System, 1-5/16” and 2” hooks, or approved equal

D. Acceptable Manufacturer: Erico Fastening Products or approved equal.

E. J-hook Supports: Manufacturer’s recommended fastening devices.

2.9 INNERDUCT

A. Innerduct: NEMA TC 5. UL Listed, corrugated, specifically designed for optical fiber cable pathways.

B. Acceptable Manufactures: Arnco, Carlon, Dura-line, and Pyramid.

C. Composition:

1. Non-plenum rated: Polyethylene (PE), or High Density Polyethylene (HDPE).
2. Plenum rated: per manufacturer.

D. Nominal Size: 1” (inside diameter), minimum.

E. Pulling Strength: minimum of 600 pounds.

F. Color: Orange, solid.

G. Fittings and Innerduct Bodies: Manufacturer’s recommended fittings including couplings, adapters, end caps, end bells, expansion couplings, plugs, sleeves, a full

compliment of connective devices, and all other components to make the system work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

A. Outdoors: Use the following wiring methods:

1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
4. Underground, Grouped: RNC or PVC Externally Coated Rigid Steel Conduit where required by NEC 517.13.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

B. Indoors: Use the following wiring methods:

1. Exposed: EMT or “Wiremold” metallic raceways or equal.
2. Exposed in public areas: “Wiremold” metallic raceways or equal. Use of exposed raceways in public areas must be approved by the architect prior to installation for each location. Use of exposed EMT in areas visible to the public is not allowed unless specifically approved by the architect prior to installation. Replacement of unapproved installations of exposed raceways will be at the expense of the contractor if deemed necessary by the architect or engineer.
3. Concealed: EMT or MC-Cable. Note: MC-Cable is not approved for “homeruns”
4. Concealed in Patient Care Areas: EMT or Hospital Grade MC-Cable where allowed by code. Note: Hospital Grade MC-Cable is not approved for “homeruns”
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except in wet or damp locations, use LFMC.
6. Damp or Wet Locations: Rigid steel conduit.
7. Boxes and Enclosures: NEMA 250, Type 1, except as follows:

    a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

3.3 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Minimum Raceway Size: 1/2-inch trade size. 3/4-inch minimum for “homeruns”.

C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

D. 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.

E. Install raceways level and square and at proper elevations. Provide adequate headroom.

F. Complete raceway installation before starting conductor installation.

G. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

H. Use temporary closures to prevent foreign matter from entering raceways.

I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

K. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.

L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

M. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
4. Transition from nonmetallic tubing to rigid steel conduit or IMC before rising above floor.

N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

O. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.

P. Tighten set screws of threadless fittings with suitable tools.

Q. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.

R. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

S. Install pull wires in empty raceways. Utilize polyester line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

T. Telephone and Signal System Raceways: In addition to the above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

U. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
2. Where conduit pass from the interior to the exterior of a building.
3. Where otherwise required by NEC.

V. Apply firestopping to cable and raceway penetrations of fire-rated floor, ceiling, and wall assemblies to achieve fire-resistance rating of the assembly. Boxes installed in fire-rated floor, ceiling, and wall assemblies shall result in no larger than a 16 square-inch penetration in the fire-rated wall surface and the quantity of penetrations shall not be greater than 100 square-inches for every 100 square feet of fire-rated wall area. Where boxes are located on both sides of a fire-rated wall, the boxes shall have a

minimum of a 24” horizontal spacing, where a 24” horizontal spacing cannot be achieved, furnish and install listed fire-rated putty on the boxes as required by the IBC.

W. Route conduit through roof openings for piping and ductwork where possible; otherwise, install roof penetrations in accordance with roofing system requirements. Coordinate with roofing installer.

X. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.

Y. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

Z. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

AA. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.

BB. Conduits shall not be routed on or above the roof without prior approval from the Engineer. Instead, the branch circuits shall be routed at the structure level below the roof to feed roof-top equipment. When approval is granted to route conduits on or above the roof, the conduits shall be strapped to COOPER industries DB series support blocks at intervals not exceeding NEC requirements. The conduits shall not be rested directly on the roof. It shall be permissible to penetrate the roof adjacent mechanical or electrical equipment to power that respective equipment.

3.4 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers, at least every 8 feet.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards; disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit. Perform fastening according to the following unless other fastening methods are indicated:

1. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
2. New Concrete: Concrete inserts with machine screws and bolts.
3. Existing Concrete: Expansion bolts.
4. Steel: Spring-tension clamps on steel.
5. Light Steel: Sheet-metal screws.
6. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

N. Do not drill structural steel members.

O. All supports and attachments shall meet project seismic zone requirements.

3.5 BOX INSTALLATION

A. Do not install boxes back-to-back in walls.

B. Locate boxes in masonry walls to require cutting of masonry unit edge only. Coordinate masonry cutting to achieve neat openings for boxes.

C. Provide knockout closures for unused openings.

D. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches of box.

E. Use 4” boxes with multiple-gang mudring where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

F. Install boxes in walls without damaging wall insulation.

G. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

H. Position outlets to locate lighting fixtures as shown on reflected ceiling plans.

I. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

J. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud walls, and adjustable steel channel fasteners for flush ceiling outlet boxes.

K. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

L. For boxes installed in metal construction, use rigid support metal bar hangers or metal bar fastened to two studs or with metal screws to metal studs.

M. Set floor boxes level and adjust to finished floor surface.

N. Set floor boxes level and trim after installation to fit flush to finished floor surface.

O. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

P. Locate pull and junction boxes above accessible ceilings or in unfinished areas. Support pull and junction boxes independent of conduit.

Q. Minimum box size to be 4” square by 2 1/8” deep.

3.6 LABELING

A. Label coverplate of all pull and junction boxes by system served. Indicate panel circuits for power and lighting boxes.

3.7 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 26 05 33

SECTION 26 05 43 – UNDER SLAB AND UNDERGROUND ELECTRICAL WORK

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 under slab conduits and related electrical work.

PART 2 - PRODUCTS

2.1 CONDUIT

A. All shall be provided with fittings and accessories approved for the purpose. Refer to Section 260533.

2.2 PRECAST CONCRETE MANHOLE

A. Structural reinforced, size as indicated, with inserts for cable racks and pully eyes.

2.3 BARE COPPER GROUND CONDUCTOR

A. Medium hard drawn copper conductor, # 4/0 AWG stranded (unless otherwise noted).

PART 3 - EXECUTION

3.1 GENERAL

A. Electrical system layouts indicated on the drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit.

3.2 CONDUIT INSTALLATION

A. Plastic conduit shall be installed on 2 inch sand base and covered by 2 inch sand back fill. Multiple runs shall maintain 3 inch minimum separation between runs. Plastic

conduit shall not be installed in rock base.

B. Underground conduit entering building shall be provided with one 10 foot section of rigid steel conduit at point of penetration of foundation, footing or basement wall, with approximately equal lengths inside and outside building line. Ream the smaller inside diameter conduit smooth to prevent conductor damage.

C. Stagger conduit couplings by a minimum of 12 inches. All risers to grade shall be rigid steel.

D. All rigid steel conduits shall be encased in 3 inch minimum concrete envelope.

E. After completion of concrete encased duct bank, a 12 inch mandrel, ¼ inch less in diameter than a conduit, shall be pulled through each conduit.

F. Install 1/8 inch diameter pull line in each underground conduit.

G. Burial depths of conduits shall comply with the NEC (minimum).

H. Provide underground type plastic line markers: permanent, brightly colored, continuously printed plastic tape, intended for direct burial service, not less than 6 inches wide, reading “Caution Buried Electrical Line.” Install continuous line markers located directly over buried line at 6 inches above top of conduit, during back filling operation.

3.3 CONCRETE DUCT BANK CONSTRUCTION

A. Provide plastic spacers at maximum 5’-0” centers to maintain 3 inch spacing between conduits.

B. Drive two reinforcing bars to anchor the conduits at 10’-0” on centers to prevent floating during concrete pour.

C. Provide one warning tape (see 3.2.H. above) for each 12 inch width of concrete duct bank.

END OF SECTION 26 05 43

SECTION 26 08 00 – LIGHTING SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. This Section includes requirements for commissioning the lighting system and its controls.

B. The registered design professional is responsible to provide evidence of lighting systems commissioning and completion in accordance to the provisions of this section.

1.3 DEFINITIONS:

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

A. RDP: Registered Design Professional

B. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

1.4 COMMISSIONING DOCUMENTATION:

A. Commissioning Plan: A commissioning plan will be developed by a registered design professional or approved agency and shall include the following items:

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.
3. Functions to be tested.
4. Conditions under which the test will be performed.
5. Measurable criteria for performance

B. Test Checklists: RDP, with assistance of Architect/Engineer, shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be

tested. Prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist.

1. Name and identification of tested item.
2. Test number.
3. Time and date of test.
4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
5. Date of the test and name of parties involves as applicable.
6. Individuals present for test.
7. Deficiencies/Issues/Results of test.
8. Note if re-test is necessary.

C. Test and Inspection Reports: RDP shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. RDP shall compile test and inspection reports and tests and inspection certificates and include them in systems manual and commissioning report.

D. Corrective Action Documents: RDP shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.

E. Issues Log: RDP shall prepare and maintain an issues log that describes design, installation, and performance issues that are at variance with the Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.

1. Creating an Issues Log Entry:
   a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
   b. Assign a descriptive title of the issue.
   c. Identify date and time of the issue.
   d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
   e. Identify system, subsystem, and equipment to which the issue applies.
   f. Identify location of system, subsystem, and equipment.
   g. Include information that may be helpful in diagnosing or evaluating the issue.
   h. Note recommended corrective action.
   i. Identify commissioning team member responsible for corrective action.
   j. Identify expected date of correction.
   k. Identify person documenting the issue.

2. Documenting Issue Resolution:
   a. Log date correction is completed or the issue is resolved.
   b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.

c. Identify changes to the Contract Documents that may require action.
d. State that correction was completed and system, subsystem, and equipment is ready for retest, if applicable.
e. Identify person(s) who corrected or resolved the issue.
f. Identify person(s) documenting the issue resolution.

3. Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, RDP shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, RDP shall include the following information in the issues log and expand it in the narrative:
   a. Issue number and title.
   b. Date of the identification of the issue.
   c. Name of the commissioning team member assigned responsibility for resolution.
   d. Expected date of correction.

F. Commissioning Report: RDP shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the Contract Documents. The commissioning report shall include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances in the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
2. Commissioning plan.
3. Testing plans and reports.
4. Corrective modification documentation.
5. Issues log.
6. Completed test checklists.

G. Systems Manual: RDP shall gather required information and compile systems manual. Systems manual shall include, but is not limited to, the following:

1. Submittal Data stating equipment installed and selected options for each piece of equipment requiring maintenance.
2. Operation and maintenance data on each piece of equipment requiring maintenance. Required routine maintenance actions shall be clearly identified.
3. Name and address of at least one service agency.
4. Lighting controls system maintenance and calibration information.
5. A narrative of how each system is intended to operate, including recommended setpoints.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 TESTING:

A. Testing shall ensure that the control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturers installation instructions.

B. Testing shall ensure that the lighting controls meet all provisions of the applicable energy code.

C. Perform tests using design conditions whenever possible. Where occupant sensors, time switches, programmable schedule control, photosensor's or daylighting controls are installed, the following procedures shall be performed:

1. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance.
2. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off.
3. Confirm that the placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space as specified.

3.2 COMMISSIONING AGENT COORDINATION

A. Contractor shall coordinate with commissioning agent and complete the following work scope:

1. The contractor will be responsible to fill out the forms that UNVC creates for pre-functional testing.
2. The contractor will be responsible to fill out the forms that UNVC creates for Functional testing.
3. Contractor will be responsible for additional testing if the systems fail during our testing with them.
4. UNVC will review the4 O&M Manuals at the end of project.

END OF SECTION 26 08 00

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.

B. Related Sections include the following:

1. Section 262726 - Wiring Devices for wall-box dimmers and manual light switches.

1.3 SUBMITTALS

A. Submit shop drawings and product data, including all wiring diagrams.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: Include in all 120- and 277-V solid-state equipment. Comply with UL 1449.

2.2 TIME SWITCHES

A. Description: Electromechanical-dial type complying with UL 917.

1. Astronomic dial.
2. Two contacts, rated 30 A at 277-V ac, unless otherwise indicated.
3. Eight-day program uniquely programmable for each weekday and holidays.
4. Skip-day mode.

2.3 LIGHTING CONTROL SYSTEM

A. Description of Work: Extent of lighting control system work is indicated by drawings,

and by the requirements of this section. It is defined to include low voltage lighting control panels, switch inputs, and wiring.

1. Type of lighting control equipment and wiring specified in this section include the following: Low Voltage Lighting Control Panels.

B. SYSTEM DESCRIPTION

1. The lighting control system shall consist of low voltage relay control panels with 32 programmable switch inputs and shall offer 32 control relays.
2. Each low voltage lighting control panel shall be microprocessor controlled with an integral 4 x 16 - 64 character display and with a programming keypad.
3. Programmable intelligence shall include Time-Of-Day control, 32 holiday dates, warn occupants of an impending off, timed inputs, preset control, auto daylight savings, astronomical clock w/offsets, and local control.

TOD programming	64 Time-Of-Day/holiday schedules for 365 day
Holidays	32 holiday dates
Warn Off	Flash lights and provide an extra 1 second to 99 minutes of illumination
Preset	Pre-programmed switch patterns
Timed Inputs	Switch input timers 1-999 minutes
Timed Overrides	Timed override 1-999 minutes, resumes to normal schedule
Local Control	From alpha-numeric keypad & local switch
Astronomical	Longitude and latitude input with sunset-sunrise offsets to customize outdoor lighting Clock
Auto Daylight	Automatically adjusts the clock at the appropriate dates, selectable Savings Adjust.
Priorities	Establishes a hierarchy for inputs and network control commands
Masking	Provides permission orientation to switch inputs and network commands thereby ensuring building lighting control integrity.
Soft-Linking	Group linking for rapid programming

4. Relays may be designated as either normally open or normally closed from software. Relay status shall not only disclose commanded relay status but next scheduled state to occur.
5. Each control panel shall provide a Warn Off (flash the lights) to inform the occupants of an impending Off command. The Warn Off command shall provide an adjustable time duration of 1 second to 99 extra minutes. The occupants may exit the premises with adequate lighting or cancel the Warn Off by overriding the lighting zone. This option occurs with all Off commands except local overrides.
6. The controller shall permit lighting to be overridden on for after hours use or cleaning. The controller shall provide optional switch timer assignments or timed overrides. The override choices for various relays shall provide special event occurrences and the controller shall return to the programmed state. Also, the controller shall provide priority and masking choices to customize the functions of switch inputs, thereby enabling switches to function differently at different times of the day to meet special facility operational requirements. These overrides shall be hard-wired inputs.
7. Programming the controller shall be through the local integral keypad. Descriptive information shall assist the user to employ the system without a programming manual.
8. Priorities and/or Masking shall be assigned to inputs, telephone override, and global commands to insure building integrity. Priorities enable or disable the inputs based on Time-Of-Day scheduling in the controller. Masks shall permit: On only, Off only and On & Off control for intelligent after hours utilization of the controlled facility
9. The lighting control system may be fully programmed through PC programming software. Programming shall be permitted through a direct RS-232 or RS-485 connection, and modem.

C. HARDWARE FEATURES

1. Operator Interface: The control panel programming interface resides in firmware in the control panel. The programming interface shall consist of a circuit board mounted keypad capable of linking switch inputs to relay outputs and schedule assignments. Systems that utilize blocking diode technology for relay assignments shall not be acceptable. The integral keypad shall provide access to the main programming features. The keypad shall permit the user to manually command any or all relays individually. Each panel shall control its own loads from internal memory. A control system that relies on a central control computer/processor or external time clocks shall not be permitted.
2. Contact inputs: The control system shall permit 32 dry contacts (Digital/Switch Inputs) for override purposes. Momentary 3 wire or 2 wire (toggle) inputs shall be supported. Maintained contacts shall be supported as 2 wire (SPST) inputs. Inputs shall be dry contacts (24 VDC @ 12 ma. internally supplied to the inputs). An input shall be software linked to any number of relays for override control. The controller shall provide timers for each switch input. Each switch input timer shall

be capable of 0-999 minutes. Software shall enable or disable switch inputs based on Time Of Day scheduling.

3. Relay Type: The system shall utilize control relays which are rated to 20 amps at 277 VAC. The relays shall be magnetically held and are provided in groups of eight. Relays that are latched or mechanically held are not acceptable. The relays shall be rated for 10 million mechanical operations. A limited 10 year warranty shall be provided on the individual relays.
4. Photocell Control: The controller shall accept user adjustable ambient light sensors. The controller shall provide power for the sensor thereby eliminating any external power supply. Sensors shall provide for both outdoor and indoor applications and provide a dry contact to the controller once the threshold is reached. The sensor shall provide user adjustable dead band control.
5. Modular Design: The control system shall employ all modular connectors to avoid repeat wiring in case of component failure. The system CPU board shall be mounted on quick release hinge pins that shall permit an entire change out of the processor and input board in less than 1 minute. All connections for the switch inputs shall incorporate modular connectors. The relay board shall be modular and designed for rapid field replacement or upgrading. Systems that do not employ modular connectors shall not be acceptable.
6. Hardware Output Options
    a. Latching Relay Card (LRC): The controller shall provide an option for remote placement of the control relays. A modular card shall connect into the relay compartment. Twisted (3) conductor cable shall power and control the remote mounted relays. Maximum distance is 500 feet employing 18 AWG conductor.
    b. Modular Relay Card (MRC): The controller shall provide an option for modular relay control. The Modular Relay Card (MRC) shall offer the feature of controlling two pole voltages such as 208, 240, and 480VAC in a Normally Open or Normally Closed configuration. Single pole is offered for 120 and 277VAC in a Normally Open and Absolute Zero Configuration. This relay card shall also provide visual indication of relay status. Relays shall be individually exchangeable with plug in low voltage connectors. Combinations of relays shall be permitted since relay modules shall snap into and lock in location. Two pole modules require two relay locations for a maximum of four two pole relays per card. All other relay modules use 1 relay location for a maximum of eight per card. All Modular Relay Card components shall be warranted for 10 years.
    c. Two Pole Relay Card (TPRC): The controller shall provide an option for two pole relay control. The Two Pole Relay Card TPRC shall offer the feature of controlling two pole voltages such as 208, 240, and 480 VAC lighting loads at 20 amps. The relays shall be modular in design and offer manual hand override control. This optional relay card shall also provide a visual indication of relay status. The 208, 240 VAC version shall provide 8 relays per card whereas the 480 VAC version shall provide 4 relays per card. Combinations of relays shall be permitted since relays shall snap into location.
    d. Automatic Relay Card (ARC): The system shall utilize hybrid control relays that are rated to 20 amps at 277 VAC. The hybrid relay shall combine a high speed electronic switch with a mechanical relay to create a unique

switching device. The hybrid design shall look at each AC phase and shall close the electronic switch precisely at the absolute zero crossing. The mechanical relay in parallel shall follow and close after the in-rush current condition. The relay shall provide an integral switch for both manual hand operation and visual indication of relay status. The relays shall be rated for 10 million mechanical operations. A limited 2 year warranty shall be provided on the individual relays.

e. Lighted Switch Card (LSC): The controller shall provide an option for pilot light wall switch annunciation. A modular card shall connect into the controller board and shall provide power to illuminate pilot light switches. This option shall confirm relay operation. When a relay is in the "ON" position the pilot light switch shall be illuminated.

7. Diagnostic Aids: Each control panel shall incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids shall guide the individual in rapid troubleshooting of the system.

   The control panels shall employ both a backlit supertwist LCD and LED's that indicates:
   - POWER (LED)
   - SYSTEM OK (LED)
   - NETWORK COMMUNICATIONS (LED)
   - ON/OFF STATUS of EACH RELAY (LED & LCD)
   - SYSTEM CLOCK and DATE (LCD)
   - PROGRAMMING CONFIRMATION (LCD)
     (TOD, HOLIDAY, ON/OFF, & PRESET)

   Control systems that do not provide visual self help diagnostics shall not be acceptable.

8. Memory Back-up: The system shall utilize a memory back-up device that is system integrated and shall be non-serviceable. The data in RAM shall be protected against power interruptions lasting as long as 7 days. The power interrupt protection circuit shall be entirely maintenance-free.
9. Multi-tapped Transformer: The control panel shall incorporate the use of a multi-tapped transformer. The panel shall not require specification of voltage for each control location. The voltages of 120 & 277 VAC shall be available with each control panel.
10. Status Indication of Relays: The system shall provide visible status indication of all relays through the window of each control panel. The visual indication shall disclose On/Off status and relay number.
11. Service Override & Priority Override: The control panel shall provide a three position master-service override for the control unit. The service override shall not be accessible from the exterior.

    The master service override provides a single three position switch with the option of All Off, Auto, and All On, respectively. This master switch shall operate all of the relays in the controller. This switch shall override and supersede all commands from the logic board when the switch is in the All On or All Off position. The master

switch shall function to override all the relays should the logic board programming differ from the space function.

The system shall remember the last command to the individual relays. Upon returning the master override switch to the Auto position, the relays shall return to the most recent command state. This will occur even if the last command happened during the master override condition.

Additionally, the system shall provide external priority override for the entire panel. Through an externally maintained contact the override card shall place the panel in a priority state. This external contact will supersede any other programmed state and will command all the relays ON or OFF depending on operational choice. This priority state will continue until the external contact is removed. Once the external override is removed the control panel will return the relays to the appropriate programmed state.

12. Lockable Enclosure: Each control panel shall be enclosed in a lockable NEMA class 1 enclosure. The enclosure shall be manufactured out of 1/16" steel and shall provide pre-punched knockouts for efficient installation.
13. Panels: The low voltage controller shall exist in two sizes of relay enclosures. The enclosure maximum sizes shall be 32 relays per cabinet. The 16 size will employ two relays cards and the 32 will utilize 4 relay cards. Relays shall be provided in groups of eight relays per card.
14. High Voltage Barriers: The low voltage controller shall provide as an option the ability to provide a barrier for either voltage separation or emergency circuit separation. The 16-size enclosure shall permit one barrier and the 32-size enclosure shall permit up to three locations where the barrier(s) may be installed. The barrier shall be painted red to denote the difference.
15. Modem: The control system shall be capable of modem communications. Each control panel shall provide a serial communications port for external tele-communications. The modem shall utilize the Hayes compatibility standard and enable modem access as defined by the Bell 212A and CCITT V.22 protocol standards.
16. Telephone Overrides (TIM): The control system shall provide intelligent software for the Telephone Interface Module (TIM) option. The optional TIM unit shall allow modem communications and touch tone overrides from any touch tone phone. The control system shall be multi-tasking and permit up to one TIM for each control panel.

    Override Operation: Touch-tone interface shall permit the control panel to command pre-assigned control points On\ Off. All user interfaces shall be through the twelve Touch-tone keys on the telephone. All entries into the override system shall be prompted by a digitized voice. Systems not employing voice guided override instruction are not acceptable.

    The TIM shall provide individual control passwords. Each password shall allow a preset group designation (number of relays) and the duration of the telephone override. TIM shall also provide a password to prevent entry into the override control system.

17. Software: System provided shall include the manufactures PC based interface software package. The PC based interface software shall provide access to lighting control system files within a Microsoft Windows environment. The software package shall allow individual panel programming to be executed locally, direct connection, Ethernet connection or remotely through a modem. The central programming software shall permit the user to modify the control panel programming or configuration in an "OFF-LINE" mode. This software package shall store all programmed data and archive for future use. Systems using third party software are not acceptable.

    The following features shall be standard in the PC based software:

    a. Standard Software Features:
        i. Real Time Relay Status Monitoring
        ii. Alpha-Numeric Descriptors
        iii. Communications: Direct, Network, Ethernet and Modem
        iv. Network Status Indication
        v. Global Software Modifications
        vi. Manual Relay Commands
        vii. Remote Pattern Commands
        viii. Preset Options

    b. File Maintenance
        i. Archive Programs
        ii. Data Base Restoration
        iii. Uploading and Downloading of Programs

    Software package shall permit the PC to be utilized for other functions (i.e. word processing, data-base, & etc..) besides lighting control. Systems that require an "on-line" dedicated computer for control system operation shall not be acceptable.

18. PC Interface (RS-232 port): The controller shall permit PC programming through software. The controller shall provide a RJ-12 connection for RS-232 programming. Programming shall be permitted through either a local connection or remotely through a modem. PC software shall permit multiple file storage for data archival and for seasonal facility requirements. Operator commands may be issued directly from the PC keyboard.

D. MANUFACTURERS

1. Cooper Controls, Greengate
2. Lutron
3. Lighting Control & Design
4. Lightolier

E. PRODUCT SUPPORT AND SERVICE

1. Factory Support: Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

F. WARRANTY

1. Manufacturer shall supply a 2 year warranty on all hardware and software. A limited 10 year warranty shall be provided on the standard relay card.

2.4 PHOTOELECTRIC RELAYS

A. Description: Solid state, with single-pole, double-throw dry contacts rated to operate connected relay or contactor coils or microprocessor input, and complying with UL 773A.

B. Light-Level Monitoring Range: 0 to 3500 fc, with an adjustment for turn-on/turn-off levels.

C. Time Delay: Prevents false operation.

D. Outdoor Sealed Units: Weather tight housing, resistant to high temperatures and equipped with sun-glare shield and ice preventer.

2.5 OCCUPANCY SENSORS

A. Occupancy sensors indicated on the plans are to establish room controls and sensor quantities. The contractor is to verify sensor placement with the local manufacturer's representative or the manufacture to ensure proper coverage and functionally of the specific sensor(s) installed. The contractor is to return and make any adjustments necessary to the occupancy sensor settings and/or placement needed to maintain proper functionality within 30 days after the owner/tenant takes occupancy of the project.

B. Lighting control system shall include all occupancy sensors, power packs, and control wiring required to form a complete system.

C. All occupancy sensors shall be dual/multi technology, manufactured by Unenco, Wattstopper, Lightolier Controls, Sensor Switch, or pre-approved equal unless otherwise noted.

D. Ceiling and Wall Mount Units: Shall utilize dual/multi technology detection methods. Unit receives control power from a separately mounted auxiliary power and control unit, and operates power switching contacts in that unit.

E. Switch-Box-Mounting Units: Shall utilize dual/multi technology detection methods. Unit receives power directly from switch leg of the 120- or 277-V ac circuit it controls and operates integral power switching contacts. Unit is to have integral manual controls and is to be mounted at standard switch height.

F. Operation: Turns lights on when room or covered area is occupied and off when unoccupied, unless otherwise indicated.

1. Time Delay for Turning Lights Off: Adjustable over a range from 1 to 20 minutes, minimum. Time delay to be set at 20 minutes unless otherwise directed. Contractor shall verify time delay with the owner/tenant prior to final occupancy.
2. Manual Override Switch: Where indicated on drawings; turns lights off manually regardless of elapsed time delay.
3. Sensor shall be located and/or adjusted to detect occupancy within 1-foot of entry into room or area controlled by the occupancy sensor.

G. Auxiliary Power and Control Units: As follows:

1. Relays rated for a minimum of 20-A normal ballast load.
2. Sensor Power Supply: Rated to supply the number of connected sensors.
3. Relays shall have an auxiliary contact(s) for integration with HVAC or other building control systems.

H. Passive-Infrared Type: Detects occupancy by a combination of heat and movement in zone of coverage.

I. Ultrasonic Type: Emits a beam of ultrasonic energy and detects occupancy through use of Doppler's principle in discerning movement in zone of coverage by sensing a change in pattern of reflected ultrasonic energy. Ultrasonic frequency shall be 25 Khz or greater and sensor shall be temperature and humidity resistant.

J. Dual-Technology Type: Uses a combination of passive-infrared and ultrasonic or microphonic detection methods to distinguish between occupied and unoccupied conditions for area covered. Particular technology or combination of technologies that controls each function (ON or OFF) is selectable in the field by operating controls on unit.

K. All sensors shall be capable of operating normally with electronic ballast and compact fluorescent systems.

L. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.

M. All sensors shall have readily accessible, user adjustable controls for time delay and sensitivity. Controls shall be recessed to limit tampering.

N. In the event of failure, a bypass manual “override on” feature shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly. The override feature shall be designed for use by building maintenance personnel and shall not be readily accessible by building occupants.

O. All sensors shall provide an LED indication light to verify that motion is being detected and that the unit is working.

P. All sensors shall have no leakage current in OFF mode and shall have voltage drop protection.

2.6 MULTIPOLE CONTACTORS AND RELAYS

A. Description: Electrically operated and mechanically held, and complying with UL 508 and NEMA ICS 2.

1. Current Rating for Switching: UL listing or rating consistent with type of load served.
2. Control Coil Voltage: Match control power source.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions.

B. Wiring Method: Install all wiring in raceways.

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.3 IDENTIFICATION

A. Provide Brady wire markers or equivalent on all conductors.

3.4 FIELD QUALITY CONTROL

A. Inspect control components for defects and physical damage.

B. Verify settings of photoelectric devices with photometer.

C. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.
2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

D. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

E. The Lighting Control Panel shall be tested and listed under the UL 906 Energy Management Equipment Standards.

3.5 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

END OF SECTION 26 09 23

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SECTION 26 22 00 - DRY-TYPE TRANSFORMERS (1000 V AND LESS)

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 dry-type distribution and specialty transformers rated 1000 V and less.

1.3 SUBMITTALS

A. Product Data: Include data on features, components, ratings, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Factory Test Reports: Copy of manufacturer's design and routine factory tests required by referenced standards.

D. Sound-Level Test Reports: Copy of manufacturer's sound-level tests applicable to equipment for this project.

E. Maintenance Data: For transformers.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide transformers specified in this section that are listed and labeled as defined in the NEC.

B. Equipment shall conform or exceed requirements of NEMA, ANSI Standard C89.2 for dry-type transformers for general applications.

C. Comply with the NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Cutler-Hammer/Eaton Corp.
2. GE Electrical Distribution & Control.
3. Square D; Groupe Schneider.
4. Siemens
5. Or approved equal.

2.2 TRANSFORMERS, GENERAL

A. Description: Factory-assembled and -tested, air-cooled units of types specified, designed for 60-Hz service.

B. Cores: Grain-oriented, nonaging silicon steel.

C. Coils: Continuous windings without splices, except for taps.

D. Internal Coil Connections: Brazed or pressure type.

E. Enclosure: Class complies with NEMA 250 for the environment in which installed.

F. Low-Sound-Level Units: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

A. Comply with NEMA ST 20 and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Windings: One coil per phase in primary and secondary.

D. Electrical ratings:

1. Primary winding voltage: 480 volts, 3 phase, delta.
2. Secondary winding voltage: 120/208 volts, 3 phase grounded wye.
3. KVA rating: As indicated on drawings.

E. Enclosure: Indoor, ventilated.

F. Temperature classification:

1. Winding temperature rise shall be 150 degrees C in accordance with UL specification 506 with insulation Class 220 degree Celsius.

G. Load rating:

1. Transformer shall be capable of operating at 100% of nameplate rating continuously while in an ambient temperature not exceeding 40 degrees C.
2. Transformer shall meet the daily overload requirements of ANSI Standard C57.96.

H. Taps: For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:

1. Taps, 3 through 10 kVA: Two 5-percent taps below rated high voltage.
2. Taps, 15 through 500 kVA: Six 2.5-percent taps, 2 above and 4 below rated high voltage.
3. Taps, 750 kVA and Above: Four 2.5-percent taps, 2 above and 2 below rated high voltage.

I. K-Factor Rating: Transformers indicated to be K-factor rated are listed to comply with UL 1561 requirements for nonsinusoidal load current handling capability to the degree defined by the designated K-factor.

1. Transformer design prevents overheating when carrying full load with harmonic content corresponding to the designated K-factor.
2. Nameplate states the designated K-factor of the transformer.

J. Vibration Isolation:

1. Provide neoprene rubber pads to isolate core and coil assembly from transformer enclosure.

K. Wall-Mounting Brackets: Manufacturer's standard brackets for transformers up to 75 kVA.

2.4 BUCK-BOOST TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506 or UL 1561.

B. Description: Self-cooled dry type, rated for continuous duty, and connected as autotransformers to provide the percentage of buck or boost indicated.

2.5 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2 windings.

2.6 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: Design and routine tests comply with referenced standards.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this project if specified sound levels are below standard ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

C. Anchor transformer securely with minimum ½" diameter bolts. Strength of bolts used to secure the transformer shall be sufficient to resist shear and uplift produced by a force equal to one half of the equipment mass applied horizontally at the center of gravity.

D. Provide 1" thick resiliency pads to isolate transformer from floor or platform, Korfund "Elasto Rib" or equal.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

F. The grounding conductor for each transformer shall be routed back to the Main Grounding Bar used for the building ground system.

3.2 GROUNDING

A. Separately Derived Systems: Comply with the NEC requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

B. Comply with Section 260526 - Grounding for materials and installation requirements.

3.3 CONNECTIONS

A. Use flexible conduits at least 24" long for electrical connections.

3.4 IDENTIFICATION

A. Provide engraved lamacoid nameplate for each transformer.

3.5 FIELD QUALITY CONTROL

A. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the contract documents, and is suitable for energizing.

B. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values.

C. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.6 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.7 ADJUSTING

A. After installing and cleaning, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit to owner.

C. Adjust buck-boost transformer connections to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility.

END OF SECTION 26 22 00

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SECTION 26 24 00 – DISTRIBUTION SWITCHBOARDS

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 distribution switchboards.

B. Related section – Section 260501 Field Test and Operational Check.

1.3 REFERENCES

A. FS W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA PB 2 - Dead Front Distribution Switchboards.

D. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

1.4 SUBMITTALS

A. Submit product data and shop drawings.

B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 SPARE PARTS

A. Keys: Furnish 3 each to owner.

B. Fuses: Furnish to owner 3 spare fuses of each type and rating installed.

C. Fuse Pullers: Furnish one fuse puller to owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General Electric, Cutler-Hammer, Siemens or approved equal.

2.2 SWITCHBOARD CONSTRUCTION AND RATINGS

A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard and complete from incoming line terminals to load-side terminations. Provide lugs appropriate for conductors used.

B. Switchboard electrical ratings and configurations as shown on drawings. The short circuit current rating indicated should be an integrated rating of switchboard and its devices.

C. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials used.

D. Bus Material: Copper sized in accordance with NEMA PB 2.

E. Bus Connections: Bolted, accessible from front for maintenance.

F. Enclosure shall be NEMA PB 2 Type 1 - General Purpose. Sections shall align at front and rear.

G. Switchboard Height: 90 inches, excluding floor sills, lifting members and pull boxes.

H. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

I. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on drawings.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. Common molded case circuit breaker characteristics

1. Circuit breakers shall be constructed in accordance with the following standards:

    a. UL 489
    b. NEMA AB1
    c. CSA 22.5, No. 5
    d. Federal Specification W-C-375B/GEN
    e. IEC157-1
    f. BS4752

2. Circuit breakers shall be constructed using glass reinforced insulating material providing superior dielectric strength. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
3. Circuit breakers shall have an over center, trip free, toggle operating mechanism which will provide quick-make, quick-break contact action.
4. The circuit breaker shall have common tripping of all poles.
5. The circuit breaker handle shall reside in a "TRIPPED" position midpoint between "ON" and "OFF" to provide local trip indication.
6. Circuit breaker escutcheon shall be clearly marked "ON" and "OFF" in addition to providing International I/O markings.
7. The maximum continuous current rating and UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings shall be clearly marked on face of circuit breaker.
8. Circuit breakers shall have high interrupting ratings.
9. Circuit breakers shall be factory sealed and shall have date code on face of circuit breaker.
10. Circuit breaker/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end use equipment along with

the statement “Caution - Series Rated System”.

11. Manufacturer shall provide time/current characteristic trip curves and Ip & I2t let through curves for true current limiting circuit breakers only for each type of Circuit breaker.
12. All circuit breakers shall be UL listed for reverse connection without restrictive line and load markings and be suitable for mounting in any position.
13. Circuit breaker handle accessories shall provide provisions for locking handle in the “ON” or “OFF” position.
14. Circuit breakers shall be fixed construction with factory installed mechanical lugs.
15. All lugs shall be UL listed to accept solid and/or stranded copper and aluminum conductors. Lugs shall be suitable for 75°C rated wire.
16. All circuit breakers shall be UL listed to accept field installable/removable mechanical type or compression type lugs. Lug body shall be bolted in place, snap in design not acceptable.
17. All circuit breakers shall be capable of accepting line and/or load bus connections.

B. Thermal magnetic

1. Circuit breakers shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole providing inverse time delay and instantaneous circuit protection.
2. All circuit breakers shall have factory preset and sealed thermal trip elements. The thermal trip system shall be RMS sensing and thermally responsive to protect circuit conductors in a 400°C ambient temperature.
3. Two and three pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping of all poles. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker which allows the user to simultaneously select the desired instantaneous trip level of all poles.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboard in locations shown on Drawings, in accordance with manufacturer’s written instructions and NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Provide 2” high concrete leveling pad under switchboard. Dimension 6” larger than footprint of equipment. Anchor to pad with ½” anchor bolts.

3.2 FIELD QUALITY CONTROL

A. Testing: Refer to Section 16040 – Field Test and Operational Check.

3.3 IDENTIFICATION

A. Provide engraved lamacoid nameplate for the switchboard and each component.

B. Provide warning signs.

3.4 ADJUSTING AND CLEANING

A. Set field-adjustable switches and circuit breaker trip ranges.

B. Adjust all operating mechanisms for free mechanical movement.

C. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 00

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SECTION 26 24 13 – MAIN SWITCHBOARDS

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 main switchboards.

B. Related sections:

1. Section 26 05 01 - Field Test and Operational Check.
2. Section 26 05 26 - Grounding.

1.3 REFERENCES

A. FS W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA PB 2 - Dead Front Distribution Switchboards.

D. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

1.4 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, one line and wiring diagrams, and time-current curves of all equipment and components.

C. Field test reports – See Section 26 05 01.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data. Include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with NEMA PB2.1 and manufacturer’s written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 SPARE PARTS

A. Keys: Furnish 3 each to owner.

B. Fuses: Furnish to owner 3 spare fuses of each type and rating installed.

C. Fuse Pullers: Furnish one fuse puller to owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General Electric, Cutler-Hammer, Siemens, Square D Co.; Schneider Electric Brands, or approved equal.

2.2 SWITCHBOARD CONSTRUCTION AND RATINGS:

A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB 2, and complete from incoming line terminals to load-side terminations. Provide lugs appropriate for conductors used.

B. Switchboard electrical ratings and configurations as shown on Drawings.

C. Equipment shall be fully rated to interrupt symmetrical short-circuit current available at terminals or the rating indicated on the plans, whichever is higher. Series rating is not acceptable unless specifically indicated on the plans.

D. Line and Load Terminations: Accessible from the front of the switchboard, suitable for the conductor materials used.

E. Bus Material: Copper sized in accordance with NEMA PB 2.

F. Bus Arrangement: Use A-B-C sequence in left-to-right, top-to-bottom, and front-to-rear arrangement throughout.

G. Bus Connections: Bolted, accessible from front or rear for maintenance.

H. Enclosure shall be NEMA PB 2 Type 1 - General Purpose. Sections shall align at front and rear. Provide NEMA 3R Enclosure when indicated on plans.

I. Switchboard Height (NEMA 1) : 90 inches, excluding floor sills, lifting members and pull boxes.

J. Finish: Manufacturer’s standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion resisting paint, or plate with cadmium or zinc.

K. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on Drawings.

2.3 SWITCHING AND OVERCURRENT PROTECTIVE DEVICES-

A. Main Circuit Breaker Assemblies:

1. Main Circuit breakers (unless otherwise indicated on plans) shall be insulated case type as indicated on plans with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination.
2. All Main Circuit Breakers rated for 1200 Amp or higher shall have the following features:

    a. UL listed for 80 percent load application unless otherwise indicated on

plans as 100% rated.

b. Adjustable [L] Long time time-delay and ampere setting.
c. Adjustable [S] Short time-delay and pick-up.
d. Adjustable [I] Instantaneous trip.
e. Adjustable [R] Reduced Energy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
f. For 277/480Y systems rated 1000 Amp or higher - Adjustable [G] Ground fault pick-up and delay is required.
g. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.
h. Short circuit, overload and ground fault trip indicators.
i. Trip device of circuit breakers shall be of the same type for tripping coordination and shall allow for the UL listed field installation of internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Breaker shall include Accessories as indicated on plans.
j. Circuit breaker handle accessories shall provide provisions for locking handle in the 'ON' or ' OFF' position.

B. ALL Feeder Breaker Assemblies 1200 Amp and above:

1. 1. Feeder Circuit breakers 1200 Amp may be Molded Case or Individually Mounted, 1600 Amp and above shall be Insulated Case with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit breakers shall have the following features:

a. UL listed for 80 percent load application unless otherwise indicated on plans as 100% rated.
b. Adjustable [L] Long time time-delay and ampere setting.
c. Adjustable [S] Short time-delay and pick-up.
d. Adjustable [I] Instantaneous trip.
e. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
f. Adjustable [R] Reduced Entergy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
g. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.

h. Short circuit, overload and ground fault trip indicators.

D. Feeder Circuit Breaker Assemblies below 1200 Amp:

1. Feeder Circuit breakers below 1200 Amp shall be digital solid state true RMS sensing Molded Case Circuit Breakers with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit Breakers shall have the following minimum features:

   a. UL listed for 80 percent load application unless otherwise indicated on plans.
   b. Long time pickup (ampere setting) determined by interchangeable rating plug .
   c. Adjustable instantaneous with short time tracking function.
   d. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
   e. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘OFF’ position

2. Where specifically indicated or required by NEC

   a. Adjustable [L] Long time time-delay and ampere setting.
   b. Adjustable [S] Short time-delay and pick-up.
   c. Adjustable [I] Instantaneous trip.
   d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
   e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
   f. Short circuit, overload and ground fault trip indicators.
   h. Trip device of circuit breakers shall be of same type for tripping coordination.

E. Feeder Circuit Breaker Assemblies 150 Amp and below:

1. Feeder Circuit breakers 150 Amp and below shall be thermal Magnetic Circuit breaker: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits, unless otherwise indicated or required to meet Section 2.4 C above. Minimum features below:

   a. UL listed for 80 percent load application unless otherwise indicated on plans.
   b. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.

c. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘OFF’ position

2. Where specifically indicated or required by NEC

a. Adjustable [L] Long time time-delay and ampere setting with Long time pickup (ampere setting) determined by interchangeable rating plug.
b. Adjustable [S] Short time-delay and pick-up.
c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
h. Trip device of circuit breakers shall be of same type for tripping coordination.

F. Fused Switch Assemblies:

1. FS W-S-865; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: FS W-F-870. Designed to reject all except Class R fuses, type as specified.
2. Switch handles shall be provided with provisions for locking handle in the ‘ON’ or ‘OFF’ position.
3. Fusible Switch Assemblies, Larger than 800 Amperes: Bolted pressure contact switches. Fuse
4. Clips: FS W-F-870. Designed to accommodate Class L fuses.
5. Fuse Manufacturers: Bussmann, Shawmut, Brush, or approved equal.
6. Fuse Sizes: as indicated on the drawings. Provide an appropriate sized spare fuse cabinet (with nameplate and directory) with one spare set of fuses (minimum of three) for each current rating and type used on the entire project. All fuses shall be of the same manufacturer.

2.4 INSTRUMENTATION (when indicated on plans)

A. Three five ampere current transformers per breaker, including main terminated in a shorting block.

B. Three 120V potential transformers for main incoming voltage.

C. Meter .Provide a UL listed and digital multifunction power monitor. The monitor case shall be fully enclosed and shielded. The monitor shall accept a voltage monitoring range of up to 600 volts, phase to phase. The Monitor shall provide true RMS measurements of voltage, phase to neutral and phase to phase; current, per phase and neutral; real power, reactive power, apparent power, power factor and frequency. The Monitor shall monitor max/min average demand values for all current and power readings. The demand interval shall be user programmable. The Monitor shall have an accuracy of +/- 0.1% or better for volts and amps, and 0.2% for power functions, and

shall meet IEC687 (0.2%).The monitor shall include a three line, integrated, light-emitting diode (LED) display. The display shall provide user access to all phase voltages (phase to neutral and phase to phase), currents (phase and neutral) , watts, VARs, VA, power factor, frequency and kwh. The monitor shall be microprocessor based and shall be fully user programmable. The monitor shall be provided with an RS485 digital communications port. The Monitor shall communicate using a MODBUS RTU protocol and shall have a communication baud rate of at least 57k.. The monitor shall be provided with one KYZ pulse outputs

2.5 OPTIONAL FEATURES

A. When indicated on drawings, provide single phasing protection with UL listed phase monitor, relays, shunt trip coils and all necessary accessories and wiring to trip designated circuit breakers (with motor loads) when voltage of any phase drops below 88 percent of rated voltage. Taylor “Phase Guard” Model PND with a two second delay.

2.6 LUGS AND HARDWARE

A. Cable connectors shall be mechanical type lugs, suitable for copper or aluminum cables. All hardware used on conductors shall have high tensile strength and a suitable protective finish. All connections shall be made with Belville washers.

2.7 PROVISIONS FOR HANDLING

A. Provide adequate lifting means.

B. Switchboard shall be capable of being rolled or moved into installation position and bolted directly to the floor without use of floor sills.

2.8 WIRING

A. Provide all necessary control and instrumentation wiring.

B. Provide fuses, fuse blocks, control transformers, terminal blocks with suitable numbering strips, relays, auxiliary contact switches on circuit breakers as required.

C. Locate terminal blocks for remote load monitoring transducers in CT compartment for future extension by Owner.

D. All low voltage and control wiring shall be physically isolated from live busses so that safe access can be obtained without de-energizing the switchboard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboard in locations shown on Drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Provide 2" high concrete leveling pad under switchboard. Dimension 6" larger than footprint of equipment. Anchor to pad with ½" anchor bolts.

3.2 FIELD QUALITY CONTROL

A. Testing: Refer to Section 26 05 01 – Field Test and Operational Check.

3.3 IDENTIFICATION

A. Provide engraved lamacoid nameplate for the switchboard and each component.

B. Provide warning signs.

3.4 ADJUSTING AND CLEANING

A. Set field-adjustable switches and circuit breaker trip ranges.

B. Adjust all operating mechanisms for free mechanical movement.

C. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch-circuit panelboards.
2. Distribution panelboards.

B. Related sections:

1. Section 26 05 01 - Field Test and Operational Check.
2. Section 26 05 26 - Grounding.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective 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. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of panelboards and overcurrent protective devices.
d. UL listing for series rating of installed devices.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. Maintenance Data: For panelboards and components, 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.

1.4 QUALITY ASSURANCE

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

B. Comply with NEMA PB 1.

C. Comply with the NEC.

1.5 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, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Panelboards, Overcurrent Protective Devices and Accessories:

   a. Eaton Corp.; Cutler-Hammer Products.
   b. General Electric Co.; Electrical Distribution & Control Div.
   c. Siemens
   d. Square D Co.; Schneider Electric Brands
   e. Or approved equal.

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush or surface mounted cabinets (as indicated on drawings). Construct cabinets with code gauge galvanized steel. Provide minimum 20” wide cabinets and extra wiring space where incoming feed-through or parallel lines are shown. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Doors: Provide door-in-door construction, made of cold-rolled steel. Inner door shall provide access to breaker handles and outer door shall provide access to wiring space as well. Inner door shall be completely flush with no visible bolts, screw-heads or hinges and with flush catch and lock. Outer door shall have concealed hinges, flush catch and lock to match inner door, located in line with inner door catch. (Tee bar handles are not acceptable).

D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

F. Bus: Hard-drawn copper, 98 percent conductivity. Attach circuit breakers to bus so that circuits 1, 3, and 5; 2, 4, and 6, or any three similarly numbered circuits form one three-phase, four-wire circuit.

G. Main and Neutral Lugs: Compression or mechanical type suitable for use with conductor material.

H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

I. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

J. Isolated Equipment Ground Bus: Where indicated on drawings - Adequate for branch-circuit equipment ground conductors; insulated from box.

K. Extra-Capacity Neutral Bus: Where indicated on drawings, neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. Where indicated on plans, On 120/208Y Panels fed by K factor Type Transformer.

L. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor. Where indicated on plans.

M. Gutter Barrier: Arrange to isolate individual panel sections.

N. Feed-through Lugs: Compression or mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device. For two-section panels.

O. Panels located adjacent to each other shall have identically sized enclosures and trims.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating. If not series rated: Fully rated to interrupt symmetrical short-circuit current available at terminals or the rating indicated on the plans, whichever is higher.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices:

1. 120/208Y volt branch circuit panelboards: Quick-make, quick-break, molded case plug-in type designed for 120/208Y volt, three-phase, four-wire service with minimum 10,000 amperes rms short circuit rating.
2. 277/480Y volt branch circuit panelboards: Molded case bolt-on type designed for 277/480Y volt, three-phase, four-wire service with minimum 14,000 amperes rms short circuit rating.
3. Provide multi-pole units with common trip elements.
4. Breaker shall have center-tripped position in addition to the ON and OFF positions.
5. Provide lockouts for all circuits that should not be inadvertently tripped (as indicated on the drawings).

2.5 DISTRIBUTION PANELBOARDS

A. Dead-front, dead-rear, Nema 1 or 3R enclosure as indicated, designed for use on a three-phase, four-wire, 120/208Y or 277/480Y volt system. See drawings for additional details.

B. Construction: Code gauge galvanized steel fully flanged for strength and rigidity. Door and trim shall be cold-rolled steel, code gauge. Provide concealed butt hinges and 3-point catch and lock. Provide separately hinged or bolted vertical access doors over lug and wiring spaces.

C. Bus Bars: Panel shall be fully bussed. Shall be used throughout and shall be hard-rolled, electrolytic copper of 98% conductivity designed for a maximum 1000 amperes per square inch. Bars shall be factory pre-drilled to accept future field installation of 2 or 3 pole circuit breakers in any combination. Brace all bus bars for required short circuit rating of the panel, but in no case less than 35,000 amperes rms, Refer to Short Circuit information above for additional requirements.

D. Main Overcurrent Protective Devices: Circuit breaker unless otherwise noted.

E. Provide handle locking devices for all circuit breakers.

F. Provide engraved nameplates with minimum ¼” high letters secured to panel front and for each circuit protective device in panel.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Main Breaker (or Feeder) Assemblies rated for 1200 Amps:

1. Main (or feeder) breakers rated for 1200 Amp may be Molded Case with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit breakers shall have the following features:

    a. UL listed for 80 percent load application unless otherwise indicated on plans as 100% rated.
    b. Adjustable [L] Long time time-delay and ampere setting.
    c. Adjustable [S] Short time-delay and pick-up.
    d. Adjustable [I] Instantaneous trip.
    e. For 277/480Y systems rated 1000 Amp or higher - Adjustable [G] Ground fault pick-up and delay is required.
    f. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
    g. Adjustable [R] Reduced Entergy Let-Through (RELT) Instantaneous trip. This feature shall be provided on breakers to provide a temporary setting for the instantaneous trip setting of the breaker. Setting shall be adjustable down to 1.5X of the rating plug and shall be enabled through a switch mounted on front of the switchboard. The switch shall be combined with an indicating light that positively indicates that the RELT is enabled or disabled.
    h. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard.
    i. Short circuit, overload and ground fault trip indicators.

B. Feeder Circuit Breaker Assemblies 400 Amps or larger:

1. Feeder Circuit breakers 400 Amps or larger shall be digital solid state true RMS sensing Molded Case Circuit Breakers with temperature insensitive, solid state trips, current sensors and solid state logic circuit integral with the frame. All circuit breakers shall be of same design for over-current and ground fault trip coordination. The Circuit Breakers shall have the following minimum features:

    a. UL listed for 80 percent load application unless otherwise indicated on plans.
    b. Long time pickup (ampere setting) determined by interchangeable rating plug .
    c. Adjustable instantaneous with short time tracking function.
    d. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.

e. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘OFF’ position

2. Where specifically indicated or required by NEC

a. Adjustable [L] Long time time-delay and ampere setting.
b. Adjustable [S] Short time-delay and pick-up.
c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
h. Trip device of circuit breakers shall be of same type for tripping coordination.

C. Feeder Circuit Breaker Assemblies 150 Amp and below:

1. Feeder Circuit breakers 150 Amp and below shall be thermal Magnetic Circuit breaker: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits, unless otherwise indicated or required to meet Section 2.4 C above. Minimum features below:

a. UL listed for 80 percent load application unless otherwise indicated on plans.
b. Circuit Breaker shall allow the UL listed field installation internal accessories (Auxiliary Switch, Shunt Trip, Undervoltage release, Bell Alarm Switch) without removal of cover to install. Circuit Breaker shall include Accessories as indicated on plans.
c. Circuit breaker handle accessories shall provide provisions for locking handle in the ‘ON’ or ‘OFF’ position
d.

2. Where specifically indicated or required by NEC

a. Adjustable [L] Long time time-delay and ampere setting with Long time pickup (ampere setting) determined by interchangeable rating plug.
b. Adjustable [S] Short time-delay and pick-up.
c. Adjustable [I] Instantaneous trip.
d. Adjustable [G] Ground fault pick-up and delay where indicated or required be NEC.
e. Where Indicated special zone control interlocking for main breaker and future main and tie breaker of double-ended substation switchboard
f. Short circuit, overload and ground fault trip indicators.
g. Trip device of circuit breakers shall be of same type for tripping

coordination.General Breaker Requirements:

1. Minimum interrupting capacity shall match the minimum required interrupt rating of the panel.
2. Standard frame sizes, trip ratings, and number of poles.
3. Lugs: Mechanical or compression style, suitable for number, size, trip ratings, and material of conductors.
4. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
5. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
6. Shunt Trip: 120-V trip coil energized from separate circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Clearances: Minimum code required clearances around panelboards must be maintained.

C. Mounting Heights: Top of trim 78 inches above finished floor, unless otherwise indicated.

D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Mounting Hardware: Provide all necessary blocking, channels and other hardware for securing panelboards to wall, column or other parts of building structure.

F. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

G. Install filler plates in unused spaces.

H. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Label shall include panel

designation, voltage and phase in minimum ¼" high letters.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.4 FIELD QUALITY CONTROL

A. Testing: Refer to Section 260501 – Field Test and Operational Check.

B. After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Balancing Loads: After Substantial Completion, measure load balancing and make circuit changes as follows:

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.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit breaker trip ranges.

B. Adjust all operating mechanisms for free mechanical movement.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes receptacles, switches, and finish plates.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Submit shop drawings and product data.

1.5 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

B. Wiring Devices:

1. Bryant; Hubbell, Inc.
2. GE Company; GE Wiring Devices.
3. Hubbell Wiring Device – Kellems
4. Leviton Manufacturing Co., Inc.
5. Pass & Seymour/Legrand; Wiring Devices Div.
6. Cooper Wiring Devices
7. Or approved equal.

C. Wiring Devices for Hazardous (Classified) Locations:

1. Crouse-Hinds Electrical Co.; Distribution Equipment Div. or approved equal.

D. Multi-outlet Assemblies:

1. Wiremold.
2. Hubbell, Inc.; Wiring Devices Div.
3. Or approved equal.

2.2 RECEPTACLES

A. General Requirements for All Devices:

B. Each device shall have an amperage rating not less than that of the branch circuit(s) overcurrent protection device. White color, unless noted otherwise.

C. For all Emergency devices when backed up by an emergency generator, the color of the device and cover plate shall be Red.

D. 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.

E. All devices shall be Commercial Specification Grade (Construction specification grade is prohibited), unless noted otherwise.

F. All Convenience Receptacles, shall be Heavy-Duty 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; 5362 Series or similar

G. All devices in Hospitals and all patient care areas within non-hospital buildings shall be Hospital Grade.

H. Hospital-Grade, Heavy Duty, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; 8300 Series or similar

I. Straight-Blade: All devices shall be Tamper Resistant where required by the National Electric Code and/or local amendments.

J. Tamper Resistant—Convenience Receptacles: 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL5362xxTR Series or similar.

K. Tamper Resistant—Convenience Receptacles: 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL5362xxTR Series or similar.

L. GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter. Provide one device for each location, daisy-chaining devices to achieve GFCI protection is not approved for this project.

M. Duplex GFCI Convenience Receptacles, 125 V, 20 A.

N. Straight Blade, non-feed through type.

O. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.

P. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

Q. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; GFRST20xx Series or similar.

R. Isolated-Ground Receptacles: Equipment grounding contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from mounting strap, orange plastic face.

S. General Description: Straight Blade, 125 V, 20 A, Configuration 5-20R. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral TVSS in line to ground, line to neutral, and neutral to ground.

T. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.

U. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service.

V. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL5362SA Series or similar.

W. Devices: Listed and labeled as isolated-ground receptacles.

X. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

Y. TVSS Receptacles: Duplex type, NEMA WD 6, with integral TVSS in line to ground, line to neutral, and neutral to ground, blue plastic face.

Z. General Description: Straight Blade, 125 V, 20 A, Configuration 5-20R. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral TVSS in line to ground, line to neutral, and neutral to ground.

AA. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.

BB. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

CC. Subject to compliance with requirements, provide Hubbell Wiring Device-Kellems; HBL5362SA Series or similar.

DD. Mulit-Outlet assemblies: Metal with White color finish.

EE. Two-piece surface (painted steel, brushed aluminum) raceway, with factory-wired multi-outlet harness.

FF. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

GG. Receptacles: 20 A, 125-V, NEMA WD 6 Configuration 5-20R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.

HH. Receptacle Spacing: [6 inches (150 mm)] [9 inches (230 mm)] [12 inches (300 mm)] [18 inches (460 mm)].

II. Wiring: No. 12 AWG solid, Type THHN copper, [single circuit] [two circuit, connecting alternating receptacles].

2.3 SWITCHES

A. Snap Switches: General-duty, quiet type, rated 20 amperes, 120/277 volts AC. Handle: white plastic. Pilot light type (where indicated): lighted handle.

B. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible and electromagnetic noise filters.

C. Control: Continuously adjustable slide. Single-pole or three-way switch to suit connections.

D. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable slide; single pole with soft tap or other quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch wire connecting leads.

E. Fluorescent Lamp Dimmers: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming to a maximum of 1 percent of full brightness.

2.4 WALL PLATES

A. Single and combination types match corresponding wiring devices.

1. Cover plate: Smooth white plastic unless noted otherwise.
2. Cover plate for surface mounted devices: Galvanized steel.
3. Weatherproof cover plate: While in use, gasketed, cast metal, hinged device covers.
4. Plate-Securing Screws: Metal with head color to match plate finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, vertically, with height as indicated or six inches above counters.

F. Group adjacent switches under single, multigang wall plates.

G. Protect devices and assemblies during painting.

H. Install wall switches with off position down.

I. Install cover plates on switch, receptacle, and blank outlets.

3.2 IDENTIFICATION

A. Switches and receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on the outside of the face plate for receptacles and on the inside of the face plate for switches; utilize durable wire markers or tags within all outlet boxes. Labels shall be Brother ½" TZ tape, black ink on clear, extra-strength adhesive tape, with size 18 text or engineer approved equal. Use matching label printer.

3.3 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding

conductor.

C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

D. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values.

3.4 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Check each device to verify operation.

B. Test GFCI operation according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.5 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, starters, and motor control centers; and spare fuse cabinets.

1.3 SUBMITTALS

A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

1.4 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single manufacturer.

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

C. Comply with NEMA FU 1.

D. Comply with the NEC.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

1. Fuses: Furnish one set of three of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Cooper Industries, Inc.; Bussmann Div.
2. Gould Shawmut.
3. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
4. Or approved equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare fuse cabinet.

3.3 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

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SECTION 26 28 15 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED

A. Provide and install motor disconnects.

B. Provide and install circuit disconnects.

1.3 REFERENCES

A. Underwriters' Laboratory, Inc. - Annual Product Directories.

B. NEMA - Classification of Standard Types of Nonventilated Enclosures for Electric Controllers.

1.4 REGULATORY REQUIREMENTS

A. Conform to National Electrical Code and to applicable inspection authority.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Cutler-Hammer/Westinghouse, General Electric, Siemens, Square D, or approved equal.

2.2 COMPONENTS

A. Motor and circuit disconnects shall have an Underwriters' Laboratory label.

B. Single Phase 120 Volt Disconnect Switches: Single pole toggle switch with thermal overload motor protection where indicated. A Horse Power rated switch may be used where fractional horse power motors have internal overload protection.

C. Single or Three Phase Motor Disconnect Switches: two or three pole heavy duty or fusible where other loads are on same circuit, 250 or 600 volt as required in NEMA

Type 1, 3R, or 4 enclosures designed to reject all except Class 'R' fuses.

2.3 ACCEPTABLE MANUFACTURERS - FUSES

A. Cooper Bussmann, Edison, Littelfuse, Ferraz Shawmut, or approved equal.

2.4 FUSES

A. As indicated on the drawings. All shall be of the same manufacturer. Provide one spare set of fuses (minimum of three) for each current rating and type used. See Section 262813.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motor and circuit disconnect as indicated on Drawings and as required by Code. Where fuses are indicated, provide fuses correlated with full load current of motors provided.

END OF SECTION 26 28 15

SECTION 26 32 13 - PACKAGED ENGINE GENERATORS AND TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged engine-generator sets suitable for use in mission critical applications with the features as specified and indicated. Engine generators will be used as the Standby power source for the system, but shall be capable of providing reliable power with no run-time limitations while the primary source of power is unavailable.

1.3 DEFINITIONS

A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.

B. Prime Power (PRP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a variable electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the PRP unless otherwise agreed by the RIC engine manufacturer.

C. Limited Time running Power (LTP): Per ISO 8528: The maximum power available, under the agreed operating conditions, for which the generating set is capable of delivering for up to 500 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers.

D. Continuous Operating Power (COP): Per ISO 8528: The maximum power which a generating set is capable of delivering continuously whilst supplying a constant electrical load when operated for an unlimited number of hours per year under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer.

E. Data Center Continuous (DCC): The maximum power which a generating set is capable of delivering continuously whilst supplying a variable or constant electrical load when operated for an unlimited number of hours in a data center application under the agreed operating conditions with the maintenance intervals and procedures being carried out as a prescribed by the manufacturer. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 100 percent of the DCC rating.

F. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.
3. Sound test data, based on a free field requirement.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Wiring Diagrams: Control interconnection, Customer connections.

C. Certifications:

1. Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for No Preference.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

1. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.
2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
3. List of factory tests to be performed on units to be shipped for this Project.
4. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.

B. Warranty:

1. Submit manufacturer’s warranty statement to be provided for this Project.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within Idaho Falls of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Comply with NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).

E. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).

F. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 0.0 deg C (32.0 deg F) to 25.0 deg C (77.0 deg F).
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 4600.0 feet (1402.0 m).

1.8 WARRANTY

A. Base Warranty: Manufacturer shall provide base warranty coverage on the material and workmanship of the generator set for a minimum of twenty-four (24) months for Standby product and twelve (12) months for Prime/Continuous product from registered commissioning and start-up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: The basis for this specification is Cummins Power Generation equipment, approved equals may be considered if equipment performance is shown to meet the requirements herein.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.

C. Capacities and Characteristics:

1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 769.0kW, at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 4 -wire, 60 hertz.
2. Alternator shall be capable of accepting maximum 4200.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 7 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 1 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Not more than 3 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 1 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.

8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.
9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.
10. Load Sharing: Engine generator shall share real and reactive load proportionally within plus or minus 3 percent with all other engine generators in the system.

2.3 ENGINE

A. Fuel: ASTM D975 #2 Diesel Fuel

B. Rated Engine Speed: 1800RPM.

C. Lubrication System: The following items are mounted on engine or skid:

1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions

E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

F. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

G. Cooling System: Closed loop, liquid cooled

1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.
2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
6. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.

H. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.

I. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.

J. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Cycle: As required by NFPA 110 for level 1 systems.
3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.
5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:

a. Operation: Equalizing-charging rate based on generator set manufacturer’s recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring

panel.

e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.

f. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be UL 2085 listed and labeled. The fuel tank shall include the following features:

1. Capacity: Fuel for 48 Hour(s) continuous operation at 100 percent rated power output.
2. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.
3. Electrical stub up(s)
4. Normal & emergency vents
5. Lockable fuel fill
6. Mechanical fuel level gauge
7. High and low level switches to indicate fuel level
8. Leak detector switch
9. Sub base tank shall include a welded steel containment basin, sized at a minimum of 130% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
10. Fill port with overfill prevention valve (OFPV)
11. 5 gallon fill/spill dam or bucket
12. Tank design shall meet the regional requirements for the Project location

2.5 CONTROL AND MONITORING

A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.

B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

C. Manual Starting System Sequence of Operation: Switching on-off switch on the

generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter (3-phase, line to line and line to neutral values).
2. AC ammeter (3-phases).
3. AC frequency meter.
4. AC kW output (total and for each phase). Display shall indicate power flow direction.
5. AC kVA output (total and for each phase). Display shall indicate power flow direction.
6. AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
7. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
8. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
9. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
10. DC voltmeter (alternator battery charging).
11. Engine-coolant temperature gauge.
12. Engine lubricating-oil pressure gauge.
13. Running-time meter.
14. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, over load (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault alarm for generator sets rated over 1000 amps, overload warning, and overcurrent warning alarm.
18. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator

set running.

19. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
20. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
21. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
22. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
23. Paralleling Breaker control switches: The control shall include manual open and close provisions for the paralleling breaker, and LED status lamps indicating whether the breaker is open or closed.

F. Control Heater: Generator sets that are installed in outdoor enclosures, or are in tropical or coastal environments shall be provided with control heaters for anti-condensation protection.

G. Remote Alarm Annunciator: Comply with NFPA 110. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:

1. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
4. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.

5. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
6. The protective system provided shall not include an instantaneous trip function.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H

D. Temperature Rise: 150 / Class H, Standby environment.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.

G. Enclosure: Drip-proof.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding. Alternators operating at voltage higher than 690VAC shall be provided with form-wound stator coils.

J. Subtransient Reactance: 12 percent maximum, based on the rating of the engine generator set.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Sound Attenuated Steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.

B. Construction:

1. Louvers: Equipped with bird screen to permit air circulation when engine is not

running while excluding birds and rodents.

2. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
3. Exhaust System:
4. Muffler Location: Within enclosure.
5. Hardware: All hardware and hinges shall be stainless steel.
6. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
7. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.

C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.

1. Louvers: Fixed-engine, cooling-air inlet and discharge.
2. Motorized Louvers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating. Dampers shall be of a “fail open” design to allow airflow in the event of failure

D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 73 dBA measured at any location 25 ft from the engine generator in a free field environment.

E. Electrical Provisions

1. Compliance with NEC: Package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing.
2. External Electrical Connections: All power and control interconnections shall be made within the perimeter of the enclosure.

F. Site Provisions:

1. Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.

2.9 VIBRATION ISOLATION DEVICES

A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer’s standard color or as directed on the drawings.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Steady-state governing.
6. Single-step load pickup.
7. Simulated safety shutdowns.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

3.1 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.

B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer’s instructions and seismic requirements of the site.

E. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.

F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer’s recommended practice.

3.2 ON-SITE ACCEPTANCE TEST

A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:

B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.

C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance

with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.4 SERVICE AND SUPPORT

A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of $3 million or more. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.

B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within Idaho Falls of the site.

C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

END OF SECTION 26 32 13

SECTION 26 33 53 - STATIC UNINTERRUPTIBLE POWER SUPPLY

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 three-phase, on-line, static-type, UPS installations, complete with transient voltage surge suppression, input harmonics reduction, rectifier-charger, battery, battery disconnect device, inverter, static bypass transfer switch, maintenance bypass/isolation switch, output isolation transformer, and remote UPS monitoring provisions.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. LCD: Liquid-crystal display.

C. LED: Light-emitting diode.

D. THD: Total harmonic distortion.

E. UPS: Uninterruptible power supply.

1.4 SUBMITTALS

A. Product Data: Include data on features, components, ratings, and performance.

B. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.

1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring. Differentiate between field-installed and factory-installed wiring and components.

C. Factory and Field Test Reports: Comply with specified requirements.

D. Maintenance Data: Include the following:

1. Lists of spare parts and replacement components recommended being stored at project site for ready access.
2. Detailed operating instructions covering operation under both normal and abnormal conditions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

B. Store equipment in spaces with environments controlled within manufacturers' ambient temperature and humidity tolerances for non-operating equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Liebert Corporation.

B. Eaton Corporation.

C. Square D

D. Other by prior approval

2.2 FUNCTIONAL DESCRIPTION

A. Automatic operation includes the following:

1. Normal Conditions: Supply the load with ac power flowing from the normal ac power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
2. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter ac power output to the load without switching or disturbance.
3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated ac power to the load without switching or disturbance.
4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
5. If battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to a float-charge mode.
6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the

load to the normal ac supply circuit without disturbance or interruption of supply.

7. If a fault occurs in the system supplied by the UPS and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
9. If battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the load to be transferred by the static bypass transfer switch directly to the normal ac supply circuit without disturbance or interruption.
2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in the bypass mode. Device provides manual selection between the following three conditions without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and UPS rectifier-charger and inverter, or the battery and the inverter.

2.3 SERVICE CONDITIONS

A. Environmental Conditions: UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.

1. Ambient Temperature for Electronic Components: 32 to 104 deg F.
2. Ambient Temperature for Battery: 41 to 95 deg F.
3. Relative Humidity: 0 to 95 percent, non-condensing.
4. Altitude: Sea level to 4000 feet.

2.4 PERFORMANCE REQUIREMENTS

A. UPS shall perform as specified in this Article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.

B. Minimum Duration of Supply: If battery is sole energy source supplying UPS-rated full-output load current at 80 percent power factor, duration of supply is 10 minutes.

C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 20 percent from nominal voltage.

D. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.

E. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.

F. Limitation of harmonic distortion of input current to the UPS shall be as follows:

1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 10 percent, maximum, at full-rated UPS load current, for power sources with X/R ratio between 2 and 30.

G. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.

H. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of full-load rating for 10 minutes, and 150 percent for 10 seconds in all operating modes.

I. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:

1. 50 Percent: Plus or minus 8 percent.
2. 100 Percent: Plus or minus 10 percent.
3. Loss of AC Input Power: Plus or minus 5 percent.
4. Restoration of AC Input Power: Plus or minus 5 percent.

J. Input Power Factor: A minimum of 0.85 lagging when supply voltage and current are at nominal rated values and UPS is supplying rated full-load current.

K. EMI Emissions: Comply with FCC Rules and Regulations.

2.5 SYSTEM COMPONENTS, GENERAL

A. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

B. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

C. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

D. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested according to IEEE C62.41.

E. Maintainability Features: Mount rectifier-charger and inverter sections and static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

2.6 RECTIFIER-CHARGER

A. Capacity: Adequate to supply the inverter during full-rated output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

C. Rectifier-Charger Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.7 INVERTER

A. Description: Pulse-width modulated, with sinusoidal output.

B. Description: Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.8 STATIC BYPASS TRANSFER SWITCH

A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full-load current of the UPS, minimum.

2.9 BATTERY

A. Description: Sealed, valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment or on a separate battery rack, complete with battery disconnect switch.

B. Performance: 30 minute UPS back up.

2.10 UPS CONTROL AND INDICATION

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include an audible signal and a visual display.

C. Indications: Plain-language messages on a digital LCD or LED.

1. Quantitative indications shall include the following:

a. Input voltage, each phase, line to line.
b. Input current, each phase, line to line.
c. Bypass input voltage, each phase, line to line.
d. Bypass input frequency.
e. System output voltage, each phase, line to line.
f. System output current, each phase.
g. System output frequency.
h. DC bus voltage.
i. Battery current and direction (charge/discharge).
j. Elapsed time-discharging battery.

2. Basic status condition indications shall include the following:

a. Normal operation.
b. Load-on bypass.
c. Load-on battery.
d. Inverter off.
e. Alarm condition exists.

3. Alarm indications shall include the following:

a. Bypass ac input overvoltage or undervoltage.

b. Bypass ac input overfrequency or underfrequency.
c. Bypass ac input and inverter out of synchronization.
d. Bypass ac input wrong-phase rotation.
e. Bypass ac input single-phase condition.
f. Bypass ac input filter fuse blown.
g. Internal frequency standard in use.
h. Battery system alarm.
i. Control power failure.
j. Fan failure.
k. UPS overload.
l. Battery-charging control faulty.
m. Input overvoltage or undervoltage.
n. Input transformer overtemperature.
o. Input circuit breaker tripped.
p. Input wrong-phase rotation.
q. Input single-phase condition.
r. Approaching end of battery operation.
s. Battery undervoltage shutdown.
t. Maximum battery voltage.
u. Inverter fuse blown.
v. Inverter transformer overtemperature.
w. Inverter overtemperature.
x. Static bypass transfer switch overtemperature.
y. Inverter power supply fault.
z. Inverter transistors out of saturation.
aa. Identification of faulty inverter section/leg.
bb. Inverter output overvoltage or undervoltage.
cc. UPS overload shutdown.
dd. Inverter current sensor fault.
ee. Inverter output contactor open.
ff. Inverter current limit.

4. Controls shall include the following:

a. Inverter on-off.
b. UPS start.
c. Battery test.
d. Alarm silence/reset.
e. Output-voltage adjustment.

D. Dry-form "C" contacts shall be available for remote indication of the following conditions:

1. UPS on battery.
2. UPS on-line.
3. UPS load-on bypass.
4. UPS in alarm condition.
5. UPS off (maintenance bypass closed).

2.11 MAINTENANCE BYPASS/ISOLATION SWITCH

A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.

1. Switch shall be interlocked to prevent interrupting power to the load when switching to the bypass mode.
2. Switch shall isolate other UPS components electrically to permit safe servicing.

B. Comply with NEMA PB 2 and UL 891.

C. Switch Rating: Continuous duty at rated full-load current of UPS.

D. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by static bypass transfer switch. Lock is designed specifically for electrical component interlocking.

2.12 OUTPUT ISOLATION TRANSFORMER

A. Description: Unit with low forward transfer impedance up to 3 kHz, minimum. Include the following features:

1. Comply with applicable portions of UL 1561, including requirements for nonlinear load current-handling capability for a K-factor of approximately 13.
2. Output Impedance at Fundamental Frequency: Between 3 and 4 percent.
3. Regulation: 5 percent, maximum, at rated nonlinear load current.
4. Full-Load Efficiency at Rated Nonlinear Load Current: 96 percent, minimum.
5. Electrostatic Shielding of Windings: Independent for each winding.
6. Coil Leads: Physically arranged for minimum interlead capacitance.
7. Shield Grounding Terminal: Separately mounted. Labeled, "Shield Ground."
8. Capacitive Coupling between Primary and Secondary: 33 picofarads, maximum, over a frequency range of 20 Hz to 1 MHZ.

2.13 OUTPUT DISTRIBUTION SECTION

A. Panelboard: Comply with Section 16442 Panelboards, except provide assembly integral to a UPS cabinet.

2.14 UPS MONITORING BY REMOTE STATUS AND ALARM PANEL

A. Description: Labeled LEDs on panel faceplate indicate basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.

1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

2.15 MONITORING BY REMOTE COMPUTER

A. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:

1. Connectors and network interface units or modems for data transmission via RS-232 link.

2.16 BASIC BATTERY MONITORING

A. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

B. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 75 deg C occurs within the compartment.

C. Annunciation of Alarms: At UPS control panel.

2.17 SOURCE QUALITY CONTROL

A. Factory test complete UPS before shipment. Include the following tests:

1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.
6. Efficiency test at 50, 75, and 100 percent of rated full-load current at rated power factor.

B. Observation of Test: Give 14 days advance notice of tests and provide opportunity for owner to observe tests at owner's option.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install system components on 4-inch high concrete bases.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and the NEC.

C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

3.2 GROUNDING

A. Comply with Section 16060 Grounding for materials and installation requirements.

B. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NEC requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.3 IDENTIFICATION

A. Provide nameplates to identify UPS and output distribution sections. Letter height: ¼ inch; identify equipment designation. Secure nameplates to equipment front using screws or rivets.

3.4 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage the services of a factory-authorized service representative to supervise UPS installation, startup, and preliminary testing and adjustment and to participate in final tests, inspections, and adjustments.

B. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each component of the UPS:

1. Inspect interiors of enclosures, including the following:

    a. Integrity of mechanical and electrical connections.
    b. Component type and labeling verification.
    c. Ratings of installed components.

2. Test manual and automatic operational features and system protective and alarm functions.
3. Test communication of status and alarms to remote monitoring equipment.

C. Retest: Correct deficiencies and retest until specified requirements are met.

D. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals.
3. Schedule training with owner with at least seven days advance notice.

END OF SECTION 26 33 53

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SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to the project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Contactor-type service entrance automatic transfer switches.
2. Contactor-type service entrance nonautomatic transfer switches.
3. Transfer switch accessories.

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 transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
3. Include network register map for the transfer switch control

B. Shop Drawings:

1. Include outlines drawings, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Include Building Information Models (BIM) for the transfer switches
4. Single-line diagram: show connections between transfer switch, power sources,

and load; and show interlocking provisions for each combined transfer switch

5. Interconnection wiring diagrams, showing recommended conduit runs and point-to-point terminal connections to generator sets
6. Riser Diagram: Show interconnection wiring between transfer switches, annunciators, and control panels.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer-authorized service representative testing agency.

B. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.

1. Basis for Certification: Seismic certifications shall be third-party certified and based on testing. Certification based on calculations does not meet this requirement.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational both during and after the seismic event.
3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer and Supplier Qualification Data

1. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
2. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years. When requested, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. Include the following:
    a. Features and operating sequences, both automatic and non-automatic.

b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

c. Factory test reports

1.6 QUALITY ASSURANCE

A. Only approved bidders shall supply equipment provided under this contract.

B. Manufacturer Qualifications: The equipment manufacturer shall maintain a service center capable of providing training, parts, maintenance and emergency repairs to equipment, including transfer switch, generator sets, and remote monitoring equipment (if applicable) at the site within a response period of less than eight from time of notification.

1. The transfer switch shall be serviced by technicians employed by, and specially trained and certified by, the generator set manufacturer.
2. The manufacturer shall have a service organization that is factory-certified in both generator set and transfer switch service. The service organization shall be on call 24 hours per day, 365 days per year
3. The manufacturer shall maintain an inventory of critical replacement parts at the local service organization, and in-service vehicles.
4. Submit names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site.
5. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

C. Source Limitations: All transfer switches are to be obtained through one source from a single manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for products provided.

1.7 FIELD CONDITIONS

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

1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architect's, Construction Manager's, and Owner's written permission.
3. Do not energize any new service or distribution equipment without notification and permission of the (Architect, Construction Manager, Owner).

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship for a minimum of five (5) years from the warranty start date.

1. Warranty Period: The warranty start date is the date of registered commissioning and start up or eighteen (18) months from date of shipment, whichever is sooner.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc. during the minimum noted warranty period described above.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cummins Power Generation
2. ASCO
3. Caterpillar
4. Kohler
5. Others with prior approval

B. Equipment specifications for this Project are based on automatic transfer switches manufactured by Cummins Power Generation. Switches manufactured by other manufacturers that meet the requirement of this specification are acceptable, if approved not less than two weeks before scheduled bid date. Proposals must include a line-by-line compliance statement based on this specification.

C. Transfer switches utilizing molded case circuit breakers do not meet the requirements of this specification and will not be accepted.

2.2 PERFORMANCE REQUIREMENTS

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 as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.

B. Comply with NEMA ICS 10.

C. IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

D. NFPA 70, National Electrical Code. Equipment shall be suitable for use in systems in compliance with Articles 700, 701, 702 and 708 (Critical Operations Power Systems, COPS)

E. Comply with NFPA 110 Level 1, Type 10.

1. shall be permanently marked to identify it as a service disconnect.

F. Service entrance transfer switches rated at 1000A and above shall be

1. UL891 listed with UL1008 recognized transfer switch
2. Labeled as "Suitable for use only as service entrance."
3. Labeled as suitable for use in emergency, legally required, and optional standby applications.
4. Service disconnect shall be permanently marked to identify it as a service disconnect.

G. The transfer switch shall contain a disconnect device on the normal source as well as a disconnect link on the utility neutral and a disconnect link between neutral and ground.

H. EN 61000-6-2 Generic Immunity Standard

I. EN 61000-4-3 Radiated Immunity

J. EN 61000-4-4 Electrical Fast Transients

K. EN 61000-4-2 Electrostatic Discharge

L. EN 61000-4-6 Conducted Immunity

M. EN 61000-4-8 Power Frequency Magnetic Field

N. Fault-Current Withstand and Closing Ratings (WCR): UL 1008 WCR must be listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions. WCR shall be based on use of the same set of contacts for the withstand test and the closing test. WCR shall be adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Transfer switches shall have a time-duration Withstand and Closing Rating (WCR) of at least 0.05 seconds (3 cycles at 60 Hz).
2. Short-time WCR shall be rated for a duration of 0.5 seconds (30 cycles at 60 Hz).
3. Transfers switches with Withstand Ratings only and without Closing Rating shall not be acceptable. This applies for Short-time and Time Duration WCR Ratings
4. Transfer switches which are not tested and labeled with 0.05 seconds (3 cycles

at 60 Hz) time-based ratings, or applicable 0.5 seconds (30 cycles at 60 Hz) short-time rating(s) and have series, or specific breaker ratings only, are not acceptable

O. The transfer switch shall be rated to close on and withstand the available RMS symmetrical short circuit current at the service entrance transfer switch terminals with the type of overcurrent protection shown on the plans.

P. Repetitive Accuracy of Solid-State Controls: All settings should be accurate to +/- 2% or better over an operating temperature range of - 40 to + 60 degrees C (- 40 to + 140 degrees F).

Q. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

R. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric- motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

S. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously. The neutral poles shall have the same ratings as the phase poles. Overlapping neutral contacts shall not be accepted.

T. Neutral Terminal: Transfer switches that are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

U. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

V. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

W. Control: Transfer switch control shall be capable of communicating with the genset control, other switches and remote programming devices over a high-speed network interface.

X. Factory wiring: Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism

Y. Terminals: Terminals shall be pressure type and appropriate for all field wiring. Control wiring shall be equipped with suitable lugs, for connection to terminal strips.

Z. Enclosures: All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 508, unless otherwise indicated:

1. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70, regardless of the direction from which the conduit enters the enclosure.
2. Exterior cabinet doors shall provide complete protection for the system's internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are not acceptable.
3. Transfer switches shall be provided in enclosures that are third party certified for their intended environment per NEMA requirements.
4. Enclosure type: NEMA 250: Type 3R,

2.3 DISCONNECTING AND OVERCURRENT PROTECTION DEVICE

A. For service entrance transfer switches rated 3000 amps, the normal connection shall be provided with a 4-pole, air circuit breaker with current ratings as shown on the plans. The circuit breaker shall be provided with LSIG Trip Unit. The circuit breaker shall have means to be racked out.

B. An Energy Reduction Maintenance Switch (ERMS) shall be provided where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted is 1200 amps or higher.

C. The transfer switch service entrance breaker shall be equipped with Ground Fault Protection (GFP) per NEC, requirements if applicable.

2.4 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Neutral switching: Where four pole switches are indicated, provide neutral pole switched simultaneously with phase poles. The neutral bus shall be sized to carry 100% of the current designated on the switch rating. Overlapping neutral shall not be accepted
4. The transfer switch operation shall include the ability to switch to an open position (both sources disconnected) for load shedding from the generator set.
5. Switches for emergency or standby purposes shall be mechanically and

electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

6. During fault conditions, the switch shall be both electrical and mechanically held during a fault condition. For switches rated at 400A or less, and fault currents less than 65kA, transfer switch contacts which are only mechanically held shall be acceptable.
7. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
8. Switches rated 150 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts. For transfer switches 400A and below, blow-off construction shall be acceptable.
9. Switch contacts shall be encapsulated to increase phase to phase isolation and reduce the possibility of arcing between phases.
10. All major switching components and controls shall be from the same manufacturer for ease maintenance and commonality of parts.
11. Main switch contacts shall be high pressure silver tungsten alloy brazed-on. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
12. Contacts shall be 100% Restriction of Hazardous Substances (RoHS) compliant
13. Conductor Connectors: Suitable for use with conductor material and sizes.
14. Where neutral conductors are to be solidly connected as shown on the plans, a 100% rated neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.
15. Main and Neutral Lugs: Mechanical Type, unless shown differently on drawings.
16. Ground Lugs and Bus-Configured Terminators: Compression or Mechanical type. Bus stabs are also acceptable.
17. Ground bar shall be provided.
18. Connectors shall be marked for conductor size and type according to UL 1008.

C. Automatic Open-Delayed Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
2. Fully automatic break-before-make operation with center off position.
3. Fully automatic break-before-make operation when two sources have near zero phase difference.

D. Automatic Open-Fast Transition Sync: No delays but waits for the sources to be synchronized for all three parameters: phase, voltage and frequency - intended for relatively small stored energy loads such as small motors.

E. Automatic Open-Fast Transition No Sync: No time delays and no synchronization needed, intended for resistive loads only

F. Manual Operation. Instruction and equipment shall be provided for safe manual non-electric transfer in the event the transfer switch malfunctions. Authorized personnel shall be available and familiar with manual operation of the transfer switch and shall be capable of determining the adequacy of the alternate source of power prior to manual transfer.

1. Manual operation with the transfer switch door open must be performed by qualified personnel under no-load conditions only.

G. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

H. Automatic Transfer-Switch Control Features:

1. The transfer switch shall have a microprocessor-based control with a sealed membrane panel incorporating tactile pushbuttons for operator-controlled functions, and LED indicator lights for system status indicators. The control panel shall also include a color alphanumeric display for detailed system information.
2. The control shall operate over an ambient temperature range: -40 ºC to +70 ºC (-40 ºF to +158 ºF) surrounding the control
3. LCD display shall operate over an ambient temperature range of -20 ºC to +70 ºC (-4 ºF to 158 ºF) without a heater.
4. The control shall operate after being exposed to storage temperatures in the range of -40 ºC to +80 ºC (-40 ºF to 176 ºF).
5. The LCD display shall function after being exposed to storage temperatures of -30 ºC to +80 ºC (-22 ºF to 176 ºF).
6. The control shall operate over the altitude range of 0-5,000 m (16,404 ft) above sea level.
7. Control and Display, as installed in the transfer switch enclosure, shall have an ingress protection rating of IP65
8. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600 VAC. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
9. All transfer switch sensing shall be configurable from the control or from a PC-based service tool. Designs utilizing DIP switches or other electromechanical devices are not acceptable.
10. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator set.
11. Controller shall operate through a period of loss of control power.
12. Controller shall have an integrated DC power supply with:
    a. At least three diode isolated inputs to connect to three independent sources
    b. Ability to automatically switch between the isolated inputs and utilize the best available DC source.
    c. A minimum of 10 second ride-through, long enough for the emergency source to start

13. The controller shall have direct three phase sensing on both sources (S1, S2) without external transformers.
14. True RMS voltage sensing shall be provided.
15. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase- to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. The delay shall be from 0.1 seconds to 1 seconds.
16. Overvoltage Sensing for Each Phase of Normal and Alternate Source: Sense high phase- to-ground voltage on each phase. Pickup voltage shall be adjustable from 95 to 100 percent of nominal, and dropout voltage shall be adjustable from 105 to 135 percent of pickup value. The delay shall be from 0.5 seconds to 120 seconds.
17. Underfrequency Sensing for both Normal and Alternate Source: The underfrequency dropout shall be between 0.5 percent and 10 percent and a delay of 0.1 seconds to 30 seconds. The underfrequency pickup shall be between 0 percent to 100%.
18. Over-frequency Sensing for both Normal and Alternate Source: The over-frequency dropout shall be between 0.5 percent and 10 percent and a delay of 0.5 seconds to 120 seconds. The underfrequency pickup shall be between 0 percent to 100%.
19. The control shall have the ability to detect loss of phase on all three phases
20. The control shall have the ability to monitors a source (three-phase system only) to detect when there is a significant voltage difference between the different phases of the source.
21. The control shall have the ability to monitors and compares the phase rotation of each source against the system phase rotation.
22. The control shall have the ability to monitors a source (three-phase system only) to detect when there is a significant voltage difference between the different phases of the source.
23. The control shall have the ability to monitor both sources to detect when a neutral current exceeds the current threshold.
24. The control shall have a sync check function with the ability to determine when both sources of power are within specified tolerances of frequency, voltage, and relative phase difference before transferring load.
    a. Sync checks that only based on frequency and phase measurements but not voltage measurements shall not be accepted.

25. The transfer switch shall have the following adjustable time delays all built into the transfer switch control, external modules to accomplish these delays shall not be permitted:
    a. Normal to Emergency Time Delay: A time delay shall be provided on transfer to emergency, adjustable from 0 to 15,549 seconds for controlled timing of transfer of loads to emergency.
    b. Time Delay Retransfer: A time delay shall be provided for the preferred source to stabilize before the load retransfers to the preferred source, adjustable from 0 to 15,549 seconds for controlled timing of transfer of loads to emergency.
    c. Program Transition Time Delay: A time delay shall be provided to allow the transfer switch to pause in the neutral position for an adjustable duration of 0 seconds to 600 seconds whenever there is a transfer from one

source to another. The time delay shall be factory set for one second. Time delays shall be adjustable in 0.1 second increments. The time delay shall start at the loss of the source.

d. Time Delay Engine Start: A time delay shall be provided to delay the start of the standby generator set to prevent nuisance starts during short power interruptions of the preferred source, adjustable from 0 to 3,600 seconds for controlled timing of transfer of loads to emergency.

e. Time Delay Engine Cooldown: A time delay shall be provided to allow the generator set to run without load and cool down for a duration before stopping, adjustable from 0 to 3,600 seconds for controlled timing of transfer of loads to emergency.

f. Elevator Time Delay: A time delay shall be provided to allow an elevator to attempt to reach the nearest floor and open its doors, prior to a loss of power. adjustable from 0 to 600 seconds for controlled timing of transfer of loads to emergency.

g. Elevator Post Transfer Time Delay: A time delay shall be provided to energize the elevator pre-transfer output for an additional period after connecting to the destination source, adjustable from 0 to 600 seconds for controlled timing of transfer of loads to emergency.

26. The control shall have a test switch to simulate a normal-source failure.
27. The control shall have a dedicated test button to initiate or cancel a test request
28. The control shall have an override button to terminate an active exercise period
29. The control shall have an override button to terminate or bypass the following time-delays:
    a. Transfer
    b. Retransfer
    c. Engine start

30. The control shall have a reset button to reset any existing faults.
31. The control shall have the following LED indicator lights which indicate the following:
    a. Which source the load is connected to (Source 1 or Source 2)
        - Source 1 shall be green
        - Source 2 shall be yellow
    b. Which source or sources are available
    c. When switch is not set for automatic operation
    d. When the control is disabled
    e. When the switch is in test/exercise mode
    f. When there is a warning event flagged by the control

32. The control shall have pushbuttons that allow the operator to activate the following functions:
    a. Activate pre-programmed test sequence
    b. Override programmed delays, and immediately go to the next operation
    c. Reset the control by clearing any faults
    d. Test all the LEDs by lighting them simultaneously
    e. Navigate the menus to view and adjust settings and parameters

33. The control display shall be a UV-protected, colored alphanumeric display which

immediately shows the following information:

a. Date and time
b. Source 1/Source 2 voltage
c. Load KVA
d. Transfer switch name
e. Whether the control is password protected
f. Source availability
g. To which source the load is connected
h. Preferred source indication
i. Active banner that shows time delays, inhibits and test statuses
j. The color for source 1 shall be green and the color for source 2 shall be yellow.

34. The control shall have the following three levels of password security designed to restrict user access and the display shall display visually if the password is enabled:

a. User Level: Modifiable password that prevents unauthorized users from accessing the setup screen and initiating tests using the test button on the operator panel.

b. Advanced: Password that allows users access to the advanced parameters.

c. Service: password that allows users (authorized services technicians only) access to the advanced and service screens.

35. The control shall display all active alerts listed in chronological order, beginning with the most recent alert. The active alert shall have:

a. Alert type
   (i) Not in auto
   (ii) Warning
   (iii) Information
b. Fault code name
c. Fault code description
d. Date and time of occurrence
e. Fault Code Number

36. The control shall display information on a minimum of 256 events displayed in chronological order, beginning with the most recent event, about either source. The event information shall include the following:

a. Fault codes
b. Active time delays
c. Power system changes
d. Tests and exercises
e. User-driven inputs (e.g., override, transfer inhibit)

37. The control shall display the following source statistics:

a. Total Time Load Energized
b. Number of Transfers
c. Number of Retransfers
d. S1 Number of Failures
e. S2 Number of Failures

f. S1 Connected and Available
g. Total Time on S1
h. S2 Connected and Available
i. Total Time on S2
j. Transfer Time
k. Last Transfer Due to Failure

38. The control shall display real-time power source data for three phase, two phase, single phase configurations (Source 1 and Source 2):
    a. Connected Time
    b. Frequency
    c. Line to line
    d. Line to Neutral
    e. Total Harmonic Distortion (THD)
    f. Average THD
    g. Phase angle
    h. Phase rotation

39. Load metering capability shall be fully integrated to the main transfer switch control. External modules shall not be acceptable. The following parameters shall be measured and displayed with the minimum accuracies listed in parenthesis
    a. Line and neutral current (0.25 %)
    b. Line to Line and Line to Neutral Voltage (0.25 %)
    c. Frequency (0.03 Hz)
    d. Power Factor (0.25 %)
    e. Apparent Power (0.25 %)
    f. Active Power (0.25 %)
    g. Reactive Power (0.50 %)
    h. Apparent Energy (0.50 %)
    i. Active Energy (0.50 %)
    j. Reactive Energy (0.70 %)
    k. Total Harmonic Distortion (THD) (Current) (< 1.00 %)
    l. Average THD, Current (< 1.00 %)
    m. Total Harmonic Distortion THD (Voltage) (< 1.00 %)
    n. Average THD, Voltage (< 1.00 %)

40. The control shall have an "About" display that shows general information about the transfer switch and controller
    a. Controller Name
    b. Application Software (S/W) Version
    c. Calibration Part Number
    d. Controller Hardware (H/W) Version
    e. Transfer Switch Model Number
    f. Transfer Switch Serial Number
    g. System DC Voltage

41. The control shall have integrated generator set exerciser function capable of starting the generator set and transferring to it from normal source for a preset time, then retransfer and shuts down engine after a preset cool-down period. The exercise shall have the capability to support a minimum of 12 preset exercise

schedules and 12 exceptions.

a. The exercise scheduler shall have the following configuration:
- Test type
  - Test without load
  - Test with load
  - Transfer to standby
    - Transfers and keeps the load connected to the generator set (standby source) for a specified duration, regardless of the preferred source availability.
- Repeat interval
  - Once
  - First week
  - Second week
  - Third week
  - Fourth week
  - Fifth week
  - Every other week
  - Every week
- Day of week
- Start hour
- Start minute
- Start date
- Start month
- Start year
- Duration hours
- Duration minutes

b. The exercise scheduler exceptions shall have the following configuration
- Repeat interval
  - Once
  - Yearly
- Start hour
- Start minute
- Start date
- Start month
- Start year
- Duration days
- Duration hours
- Duration minutes

42. The control shall have built-in downstream load control (on/off sequencing) of at least two independent loads to prevent overloading the generator set source while continuing to power higher priority loads. Auxiliary hardware to achieve this function shall not be accepted. This functionality shall have the capability to do the following:

a. Add load:
- Block Load (Load 1 and Load 2 simultaneously), or
- Sequential time dependent load add (Load 1 then Load 2). The time delay shall be adjustable from (0-180 seconds).

b. Shed load:

- Source frequency and time-delay dependent
- Sheds lowest priority first

c. This feature shall also be capable of automatically re-adding load(s) after an overload occurs. This feature shall be capable of being enabled or disabled.

43. Customer Inputs, Outputs, Dry-Contacts - The transfer switch control shall have a minimum of the following Inputs/Outputs/Dry-Contacts:
    - Remote Test
    - Remote Override
    - Transfer to Standby
    - Transfer Inhibit
        - Transfer Inhibit: Shall keep the transfer switch connected to normal power source regardless of condition of emergency source.
    - Re-transfer Inhibit
        - Re-Transfer Inhibit: Shall keep the transfer switch connected to emergency power source as long as it is available regardless of condition of normal source.
    - Battery Charger Fault (accepts a wired input from an external battery charger and allows for custom text message to be displayed on the screen)
    - S1 Shutdown Fault Active
    - S2 Shutdown Fault Active
    - External Fault Input
    - Load Shed
    - Dual Standby Start Inhibit
    - S1 Standby Start
    - S2 Standby Start
    - S1 Available
    - S2 Available
    - S1 Connected
    - S2 Connected
    - Test Active
    - Up to four Fault Codes (Configurable to any fault code supported by the transfer switch control)
    - Elevator Pretransfer
    - Elevator Post Transfer
    - Synchronizer Enable
    - Load Contact 1
    - Load Contact 2
    - Quantity 2 digital inputs
    - Quantity 6 digital outputs
    - Quantity 1 dry Form-C contacts driven through the control onboard relays

44. Transfer Switch Auxiliary Contacts:

a. Auxiliary contacts shall be driven by the transfer switch mechanism and shall be rated 10 A at 250-VAC, 5A at 30-VDC minimum. Contacts shall be the following:

- Quantity 2 for each source indicating source connection
- Auxiliary contacts shall be isolated.

b. Optional Auxiliary contacts. The transfer switch shall have additional optional auxiliary contacts and the contacts shall be driven by the transfer switch mechanism and shall be rated 10 A at 250-VAC, 5A at 30-VDC minimum. Contacts shall be the following:

- Quantity 2 for each source indicating source connection

45. Network communication protocols: The controls shall have integrated communication capabilities. External and additional modules shall not be accepted. The communication protocols shall be
    a. Modbus RTU RS485 (Isolated). At least one port.
    b. Modbus Ethernet TCP/IP (Isolated). At least two ports
        - The control shall have the capability to turn off the Ethernet ports, if needed.
    c. USB B-Type service-tool port with dust cover.

I. Large-Motor-Load Power Transfer:

1. Programmed Neutral Switch Position: Switch mechanism shall have a neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, adjustable time-controlled pause at midpoint during transfer.

2.5 NONAUTOMATIC TRANSFER SWITCHES (OPTIONAL)

B. General information: Non-automatic is a transition type, where the control continues to monitor the sources to display source availability on the screen but does not operate the transfer switch mechanism, requiring the user to operate the transfer switch using manual selector switches.

C. The following hardware shall be provided to use in non-automatic transition:

1. Two selector switches shall be installed on the front panel of the transfer switch:
    a. Local/Remote Selector Switch (2-position switch) shall be provided. When the selector switch is moved to local, the source selection is chosen based on the Source Selector switch. When Remote is selected, the source selection signal will come from the terminal block connection point, where a user can have an external/remote switch to request the transfer
    b. Source Selector Switch (3 position switch) shall be provided to switch between Source 1 or Source 2 and spring-return to center position once released.

2. Wiring harness that connects the switches to the control as well the terminal

block.

B. Transfer Operation: Shall be electrically actuated by the Source Selector Switch to switch the load to either Source 1 or Source 2 if the source is energized.

C. Factory wiring: Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism

D. Terminals for Interconnection: Terminals shall be screw type and appropriate for all field wiring for interconnecting to the transfer switch. Communication wiring over Ethernet TCP/IP shall be the standard RJ45 connection. Communication wiring over Serial RTU shall be screw-type connection.

2.6 TRANSFER SWITCH ADD-ONS/ACCESSORIES

A. Source Surge Protection Device (SPD):

1. The SPDs shall be factory installed and wired and shall include a display and LED indicators.
2. Source 1: Transfer switch shall include a 3-phase SPD for Source 1 and a door mounted display that indicates when a phase has seen a surge event. Individual phase modules shall be replaceable after surge events. SPD shall be designed for electrical surges up to 120kA/240 kA on WYE Systems

B. Remote Annunciator System:

1. Source Limitations: shall be same manufacturer as transfer switch in which installed.
2. Functional Description: remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
    a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
    c. Switch in test mode.
    d. Failure of communication link.

3. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
    a. Indicating Lights: Grouped for each transfer switch monitored.
    b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    c. Switch in test mode.
    d. Lamp Test: Push-to-test or lamp-test switch on front panel.

4. Malfunction of annunciator or communication link shall not affect functions of

transfer switch. In the event of failure of communication link, transfer switch automatically reverts to stand-alone, self-contained operation.

5. Transfer switch sensing, controlling, or operating function shall not depend on remote panel for proper operation. The remote annunciation system shall not prevent transfer to the alternate source when the primary power source fails, nor prevent return to the primary source if the alternate source fails

2.7 SOURCE QUALITY CONTROL

A. Prior to shipping, factory shall test and inspect components, assembled switches, and associated equipment to ensure proper operation.

B. Factory shall provide end of line test reports shipped with each transfer switch.

C. Factory shall check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in- Place Concrete."

2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

4. Provide workspace and clearances required by NFPA 70.

B. Annunciator Panel Mounting: Flush Mount in wall unless otherwise indicated.

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

F. Provide certification of IBC Seismic compliance

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary, to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.

D. Transfer switch shall be provided with AL/CU mechanical lugs or compression lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

H. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

I. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Cabling."

J. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.

K. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: The manufacturer of the transfer switch(es) and associated equipment shall inspect, test, and adjust components, assemblies, and equipment installations, including connections, and report results in writing.

B. Manufacturer’s representative shall perform tests and inspections and prepare test reports.

C. After installing equipment and after electrical circuitry has been energized, installer shall test for compliance with requirements.

1. Perform recommended installation tests as recommended in manufacturer’s installation and service manuals.
2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Verify time-delay settings.
    c. Verify that the transfer switch is accurately metering AC voltage.
    d. Test functional modes and related automatic transfer-switch operations.

e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service seminar covering generator set and transfer switch equipment, for up to 10 people employed by the Owner.

1. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures.
2. The class duration shall be at least 8 hours in length and include practical operation with the installed equipment.

3.5 SERVICE AND SUPPORT

A. The transfer switch manufacturer shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of $3 million or more. The manufacturer of the transfer switch shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.

B. The transfer switch shall be serviced by a local service organization that is trained and factory certified in transfer switch service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within 90 miles of the site.

C. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

3.6 SERVICE AGREEMENT:

A. The supplier shall include in the base price, a one-year service agreement. The maintenance shall be performed by factory authorized service technicians capable of servicing both the engine generator set and the transfer switch (es). This agreement shall include the following:

1. All electrical controls maintenance and settings as recommended by the manufacturer.
2. All auxiliary equipment as a part of the emergency systems.
3. The supplier shall guarantee emergency service.
4. All expendable maintenance items are to be included in this agreement.
5. A copy of this agreement and a schedule shall be given to the Owner at the time acceptance, showing what work is to be accomplished and when.

3.7 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

END OF SECTION 26 36 00

SECTION 26 43 14 - TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 WORK INCLUDED

A. Transient Voltage Surge Suppression (TVSS) or Surge Protective Device (SPD) suitable for protection of electronic equipment and electrical systems 600 volts or less.

B. Definition: The term Transient Voltage Surge Suppression (TVSS) describes the equipment called a Surge Protective Device (SPD) necessary for the protection of all AC electrical circuits and equipment from the affects of lightning induced voltages, external switching transients, and internally generated switching transients resulting from inductive and/or capacitive load switching.

1.3 REFERENCES

A. Underwriters Laboratories, Inc. (UL) No. 1449 Rev. 2 Standard for Fire and Safety-TVSS

B. Institute of Electrical and Electronics Engineers (IEEE) Std. 142-Recommended Practice for Grounding and Std. 518-Recommended Guide on Electrical Noise ANSI/IEEE C62.41-1991 Edition.

C. Federal Information Processing Standards Publication 94 (FIPS PUB 94).

1.4 SUBMITTALS

A. Submit product data under provisions of Division 1.

B. Manufacturers' Product Data: Submit material specifications and installation data for products specified under Part 2.

C. Performance Specification: The specification shall provide the minimum information as listed below.

1. Electrical characteristics and ratings for each type of SPD.
2. Drawings shall be provided indicating SPD's dimensions, weights, mounting provisions, and connection details to the power system.
3. Provide documentation of the SPD's UL 1449 listing. Any submittal without this documentation will be rejected.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Current Technology, Cutler Hammer/Westinghouse, General Electric, Southern Tier Technologies, Siemens, Square D or Tycor International.

B. Substitutions: Under provisions of Division 1.

2.2 GENERAL

A. The TVSS System as required, shall consist of a Service Protection Panel for each service rated 600 volts or less, and Branch Panel Protectors as indicated on the drawings.

B. All devices shall operate as a total coordinated and engineered system, as well as being engineered as a system by the manufacturer.

C. Maximum continuous operating voltages of any system component shall not be less than 115 percent of the nominal system operating voltage.

D. All TVSS components shall be rated with an operating temperature range of 30 to 120 degrees Fahrenheit, and from 0 to 85 percent humidity noncondensing.

E. TVSS components shall operate in altitudes up to 20,000 feet above sea level.

F. No system component shall generate appreciable magnetic fields or sufficient fields to damage stored magnetic data.

G. Average power consumption of any single TVSS system shall be 1 watt per phase or less with zero percent total harmonic distortion.

H. Nominal system frequency is 60 Hertz; operating frequency range of the TVSS system shall be 0 to 400 Hertz.

I. All SPD's shall be connected in parallel with the power system they are protecting. Series connected components shall not be used. Suppression paths shall not be ground.

J. All SPD's shall be UL 1449 Rev 2 listed and bear the UL label.

K. All SPD's shall be equipped with integral in line fusing.

L. All SPD's shall bolt directly to the panelboard bussing or utilize a specialized cable designed to minimize voltage let-thru in the event of a surge.

2.3 MAIN SERVICE SPD

A. The Main Service SPD enclosure shall be NEMA '1' construction, factory primed and painted.

B. The Main Service SPD shall be installed parallel via a circuit breaker or fused switch rated for the interrupting current of the Main Switchboard or Panel, or the unit shall have 200K AIC internal fuses for direct bus bar mount.

C. During normal suppression operation, the unit shall not short circuit or crowbar the power flow that would result in an interruption to the load.

D. Unit shall not require interruption of building power for maintenance.

E. Provide visual indication on the cover of the enclosure to indicate proper systems operation.

F. Surge Current Capacity: Total surge current per phase (based on an 8 x 20 microsecond waveform) that the device is capable of surviving shall not be less than 250 kA per phase, or 125 kA per mode on L-G, L-N and N-G (WYE system); L-L and L-G (Delta system).

G. The Main Service SPD shall be UL 1449 Rev 2 listed for Permanently Connected Products. The surge voltage rating (SVR) per UL 1449 Rev 2 shall be as follows for each service voltage:

Voltage Configuration	UL (SVR) Level
120 Volts, Single Phase	400 Vpk (L-N)
240/120 Volt, Single Phase	400 Vpk (L-N)
208Y/120 Volt, Three Phase	400 Vpk (L-N)
240 Volt, Single Phase	500 Vpk (L-L)
240 Volt, Three Phase, Delta	600 Vpk (L-L)
480Y/277 Volt, Three Phase	800 Vpk (L-N)
480 Volt, Three Phase, Delta	1000 Vpk (L-L)

H. ANSI/IEEE Category C3 Let Through Voltage: The let through voltage based on IEEE C62.41 and C62.45 recommended procedures for Category C3 surges (20 kV, 10 kA) shall be less than:

Modes	208Y/120	480Y/277
L-N	500V	900V

I. ANSI/IEEE Category B3 Let Through Voltage: Let through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Category B3

ringwave (6 kV, 500 amps) shall be less than:

Modes	208Y/120	480Y/277
L-N	130V	200V

J. Withstand: Each unit must be capable of surviving more than 3000 ANSI/IEEE C62.41 Category C transients without failure or degradation of UL 1449 Rev 2 SVR.

K. The voltage protection level (clamping voltage) shall be provided for a 10x1000 microsecond waveform per ANSI/IEEE C62.41-1991 for B3 location categories using IEEE C62.45-1987 testing techniques (power applied). The voltage protection level (clamping voltage) shall not exceed the SVR rating provided in paragraph 2.3 G. above.

L. The Service Panel TVSS shall be furnished with terminal connections capable of accepting up to #1/0 conductors.

M. The transient suppression capability shall be equal bi-directionally and shall treat both the positive and negative impulses with separate suppressor modules per phase.

N. Electrical Noise Filter: Each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 50 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283.

O. Suppression shall be line to neutral, line to ground, and neutral to ground with the exception of a delta configuration which is line to line.

2.4 BRANCH PANEL SPD

A. Where Branch Panel SPD's are installed in conjunction with a Main Service SPD, it shall operate as a totally coordinated engineered system. It shall achieve performance equal to or better than the UL 1449 Rev 2 rating of the source point unit.

B. The Branch Panel SPD shall be listed to UL 1449 Rev 2.

C. The suppression path shall not be ground.

D. The unit shall not short circuit or crowbar the power flow that would result in an interruption to the load.

E. Scheduled parts replacement or preventative maintenance shall not be required.

F. The modules shall be bi-polar and bi-directional treating negative transients identically to positive transients with separate positive and negative suppression modules.

G. The Branch Panel SPD enclosure shall be NEMA '1' construction, and be factory primed and painted.

H. The SPD's shall be furnished with power on indication status (one per phase).

I. Surge Current Capacity: Total surge current per phase (based on an 8 x 20 microsecond waveform) that the device is capable of surviving shall not be less than 120 kA per phase, or 60 kA per mode on L-G, L-N and N-G (Wye system); L-L and L-G (Delta system).

J. The Branch Panel SPD shall be UL 1449 Rev 2 listed for Permanently Connected Products. The surge voltage rating (SVR) per UL 1449 shall be as follows for each service voltage:

Voltage Configuration	UL (SVR) Level
120 Volts, Single Phase	400 Vpk (L-N)
240/120 Volt, Single Phase	400 Vpk (L-N)
208Y/120 Volt, Three Phase	400 Vpk (L-N)
240 Volt, Single Phase	500 Vpk (L-L)
240 Volt, Three Phase, Delta	600 Vpk (L-L)
480Y/277 Volt, Three Phase	800 Vpk (L-N)
480 Volt, Three Phase, Delta	1000 Vpk (L-L)

K. ANSI/IEEE Category C3 Let Through Voltage: The let through voltage based on IEEE C62.41 and C62.45 recommended procedures for Category C3 surges (20 kV, 10 kA) shall be less than:

Modes	208Y/120	480Y/277
L-N	500V	900V

L. ANSI/IEEE Category B3 Let Through Voltage: Let through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Category B3 ringwave (6 kV, 500 amps) shall be less than:

Modes	208Y/120	480Y/277
L-N	130V	200V

M. Lifecycle: Each unit must be capable of surviving more than 2500 Category C transients without failure or degradation of UL 1449 clamp voltage.

N. The Branch Panel SPD shall be integral with the panelboard and bolt directly to the panelboard bussing or utilize a specialized cable designed to minimize voltage let thru in the event of a surge.

O. Electrical Noise Filter: Each unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 50 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283.

PART 3 - EXECUTION

3.1 WARRANTY

A. Warranty: The equipment shall be warranted against defects in material and/or workmanship for a minimum of five years.

3.2 INSTALLATION

A. The installation shall comply with the manufacturers' printed instructions, and any national and local wiring codes.

3.3 IDENTIFICATION

A. Refer to Electrical Identification, Section 16195, for identification requirements.

3.4 FIELD QUALITY CONTROL

A. The TVSS System shall be installed in accordance with the manufacturers' printed instructions to maintain warranty.

B. Upon completion of installation, the TVSS System shall not require testing of any kind.

END OF SECTION 26 43 14

SECTION 26 51 00 - INTERIOR LIGHTING

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 interior lighting fixtures, lighting fixtures mounted on exterior building surfaces and recessed in canopies, lamps, ballasts, emergency lighting units, and accessories.

B. Related Sections include the following:

1. Section 260923 Lighting Control Devices.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features and accessories.

B. Maintenance data for lighting fixtures.

C. Emergency lighting units including battery and charger.

1.4 QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in the NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with the NEC.

C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC

equipment, fire-suppression system, partition assemblies, and other construction.

1.6 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: As indicated on the drawings.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. 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.

D. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
2. Lens Thickness: 0.125 inch minimum, unless greater thickness is indicated.

2.3 FLUORESCENT LAMP BALLASTS

A. General Requirements: Unless otherwise indicated, features include the following:

1. Designed for type and quantity of lamps indicated at full light output.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Sound Rating: A.

B. Electronic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:

1. Certified Ballast Manufacturer Certification: Indicated by label.
2. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.

C. Electromagnetic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:

1. Type: Energy saving.
2. Certified Ballast Manufacturer Certification: Indicated by label.

D. Ballasts for Compact Lamps: Electronic programmed start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
11. Ballast Case Temperature: 75 deg C, maximum.

E. Ballasts for Dimmer-Controlled Fixtures: Comply with general and fixture-related requirements above for electronic ballasts.

1. Compatibility: Certified by manufacturer for use with specific dimming system indicated for use with each dimming ballast.

F. Ballasts for Low-Temperature Environments: As follows:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.

    a. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

2.4 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Type: Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.
2. Operating Voltage: Match system voltage.
3. Minimum Starting Temperature: Minus 22 deg F for single lamp ballasts.
4. Normal Ambient Operating Temperature: 104 deg F.
5. Open-circuit operation that will not reduce average life.

B. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter-starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C

C. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

1. Open-circuit operation shall not reduce average lamp life..

2.5 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:

1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.

B. Internally Lighted Signs: As follows:

1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Battery: Sealed, maintenance-free, nickel-cadmium type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Remote Test – Where indicated on the drawings: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7. Integral Self-Test – Where indicated on the drawings: Factory-installed

electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 EMERGENCY LIGHTING UNITS

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate 1 fluorescent lamp continuously at an output of 1100 lumens for 90 minutes. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space. Provide integral to fixture or mounted adjacent to fixture.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
5. Battery: Sealed, maintenance-free, nickel-cadmium type.
6. Charger: Fully automatic, solid-state type with sealed transfer relay.
7. Night-Light Connection: Where night-light option is called out in the drawings, operate one fluorescent lamp continuously.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate 1 or 2 fluorescent lamps continuously at an output of 1100 lumens for 90 minutes. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Battery: Sealed, maintenance-free, nickel-cadmium type.
3. Charger: Fully automatic, solid-state, constant-current type.
4. Housing: NEMA 250, Type 1 enclosure.
5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

C. Cold weather Compact Fluorescent: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, integral or remote mounted from lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate 1 or two fluorescent lamps continuously at a

minimum output of 1100 lumens for 90 minutes. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. Battery: Sealed, maintenance-free, nickel-cadmium type.
3. Charger: Fully automatic, solid-state, constant-current type.
4. Housing: NEMA 250, Type 1 enclosure for remote-mounted.
5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
7. Operating Temperature Range: -20° C to +55° C (-4° F to +131° F)
8. Ballasts shall be equivalent to or exceed performance as follows:

    a. Outdoor Compact Fluorescent Fixtures: Bodine B4CF1 or B4CF2
    b. Outdoor Linear Fluorescent Fixtures: Bodine B50 Cold-Pak

2.7 LAMPS

A. Fluorescent Color Temperature and Minimum Color-Rendering Index: 3500 K and 85 CRI, unless otherwise indicated.

B. Non-compact fluorescent Lamp Life: Minimum rated average is 20,000 hours at 3 hours per start.

C. Compact fluorescent Lamp Life: Minimum rated average is 12,000 hours at 3 hours per start.

D. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3700 K and 65 CRI, unless otherwise indicated.

E. Horizontally mounted Metal-Halide lamps shall be Venture Lamps series H-75 lamps.

2.8 FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

C. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.

D. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

F. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

2.9 FINISHES

A. Fixtures: Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
2. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

B. Furnish and install a protective barrier around fixtures that are not insulation-contact-rated (non-IC-rated) in locations where insulation is installed. The protective barrier shall be installed to yield a 4” air-gap from the fixture on all sides and top.

C. Support for Fixtures in or on Grid-Type Suspended Ceilings: Attach supports to building structure.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

D. Suspended Fixture Support: As follows:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings.

3.2 CONNECTIONS

A. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Tests: As follows:

1. Verify normal operation of each fixture after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.

C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

D. Ballasts: Replace all noisy ballasts. Ballasts that can be heard shall be considered noisy. Repeat the procedure until a ballast is installed that is not noisy.

3.4 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 26 51 00

SECTION 26 56 00 - EXTERIOR LIGHTING

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 exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories.

B. Related Sections include the following:

1. Section 260923 - Lighting Control Devices.
2. Section 265100 - Interior Lighting for interior fixtures, lamps, ballasts, emergency lighting units, and accessories; and for exterior luminaires normally mounted on buildings.

1.3 DEFINITIONS

A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.

B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

1.4 SUBMITTALS

A. Product Data: For each type of lighting unit indicated, arranged in order of lighting unit designation. Include data on features, accessories and finishes.

B. Maintenance data for lighting units.

1.5 QUALITY ASSURANCE

A. Luminaires and Accessories: Listed and labeled as defined in the NEC, Article 100, for their indicated use, location, and installation conditions by a testing agency acceptable to authorities having jurisdiction.

B. Comply with ANSI C2.

C. Comply with the NEC.

1.6 DELIVERY, STORAGE, AND HANDLING OF POLES

A. Retain factory-applied pole wrappings on metal poles until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: As indicated on the drawings.

2.2 LUMINAIRES

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

D. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange to disconnect ballast when door opens.

E. Exposed Hardware Material: Stainless steel.

F. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.

G. Lenses and Refractors: Materials as indicated. Use heat- and aging-resistant, resilient gaskets to seal and cushion lens and refractor in luminaire doors.

H. High-Intensity-Discharge Ballasts: Comply with ANSI C82.4. Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.

1. Ballast Fuses: One in each ungrounded supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
2. Single-Lamp Ballasts: Minimum starting temperature of minus 40 deg C.
3. Open-circuit operation will not reduce average life.
4. High-Pressure Sodium Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 deg C.
5. Noise: Uniformly quiet operation, with a noise rating of B or better.

I. Verify availability of space to install device at or close to ballast. Unit as specified is suitable for full 15-a branch-circuit protection. Coordinate with Drawings.

J. Lamps: Comply with the standard of the ANSI C78 series that is applicable to each type of lamp. Provide luminaires with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a luminaire, provide medium wattage lamp recommended by manufacturer for luminaire.

1. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated.

2.3 LUMINAIRE SUPPORT COMPONENTS

A. Description: Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

B. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 80 mph with a gust factor of 1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

C. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.

D. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Will not cause galvanic action at contact points.
2. Mountings: Correctly position luminaire to provide indicated light distribution.
3. Anchor Bolts, Nuts, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.
4. Anchor-Bolt Template: Steel.

E. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.

F. Steel Poles: Tubing complying with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in length with access handhole in pole wall.

G. Steel Mast Arms: Fabricated from NPS 2 black steel pipe, continuously welded to pole attachment plate with span and rise as indicated.

H. Metal Pole Brackets: Match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate luminaire.

I. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

J. Concrete for Pole Foundations: Comply with Division 3.

2.4 FINISHES

A. Steel: Grind welds and polish surfaces to a smooth, even finish.

1. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A 123.
2. Surface Preparation: Clean surfaces to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel.
3. Interior: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
4. Polyurethane Enamel: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
5. Color: As indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Concrete Foundations: Construct according to Division 3.

B. Install poles as follows:

1. Use web fabric slings (not chain or cable) to raise and set poles.
2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
3. Secure poles level, plumb, and square.
4. Grout void between pole base and foundation. Use non-shrinking or expanding concrete grout firmly packed in entire void space.
5. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

C. Luminaire Attachment: Fasten to indicated structural supports.

D. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 CONNECTIONS

A. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

B. Ground metal poles/support structures.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed unit for damage. Replace damaged units.

3.4 CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

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SECTION 27 00 10 - TECHNOLOGY GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS AND DEFINITIONS

A. Scope: This specification section applies to all Division 27 specification sections and all Division 28 specification sections with the exception of Fire Alarm. All systems under the specifications indicated above are referenced also in this contract documents as “technology systems”.

B. Drawings and specifications: The words “drawings” and “specifications” used on this section refer to all contract drawings and specifications describing the scope of work of the technology system.

C. Installer and Contractor: The word “installer” where used on the drawings or specifications without any further description shall reference the installer of the system under reference. The word “contractor” where used on the drawings or specifications without any further description shall reference to the General Contractor (or Construction Manager) holding the prime agreement with the owner for the construction of this project.

D. Provide and Install: The word, "provide" where used on the drawings or specifications shall mean, "furnish, install, mount, connect, test, complete, document and make ready for operation". The word "install" where used on the drawings or specifications shall mean, "mount, connect, test, complete, and make ready for operation".

E. The word Engineer (also referenced as A&E) where used on the drawings or specification refers to the design engineer of the project working for the project architect or the owner. It does not refer to an engineer working for the General contractor, Construction Manager or any of the installers in the project.

F. Complete systems: All technology systems are intended to be complete systems, including all materials, labor and programming to make it an operation system. A Responsibility matrix has been included with the contract documents to clarify the scope of all system. Refer to attachment 2 of this specification section [Refer to design drawings for matrix details]

G. Active equipment: Active equipment is defined as equipment composed of electronic component and electric materials, design to work with power applied to it. Cables are not considered active equipment.

1.2 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

A. Objective: The intent of the design drawings and specifications is to provide the installer of a technology system a scope of work for bidding purposes and to make sure

different bids received by the entity holding the bidding for the technology system are at the same level of scope for comparison purposes. The drawings and specifications are not intended to show every single element of the project to produce a buyout list for the installer. In general, for all technology systems, all active components are specifically called out but small wires and small installation materials (such as nut, bolts, washers, termination blocks, clamps, ties, etc) are not indicated in the documents. Guidelines for installation of those systems are provided in the specification to allow the installer to produce the complete buyout list of materials.

B. Accuracy: The Drawings are diagrammatic and are not intended to show exact locations of conduit runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, conduits, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Architect or Engineer during construction. Obtain in the field all information relevant to the placing of technology systems work and in case of interference with other work, proceed as directed by the Architect or Engineer.

C. Distances: Although most drawings have a scale referenced on each sheet, the drawings are a two dimensional representation of the system, so design drawings do not indicate changes in elevation that cause additional lengths and quantities of materials. It is the responsibility of the installer of each technology system to field verify all distances before bidding to properly estimate all cable distances and materials.

D. Discrepancies: Notify the A&E of any discrepancies found during construction of the project and do not proceed with that portion of the project, until a written definitive statement is received providing clear direction. If a conflict exists between the contract documents and any applicable code or standard, the most stringent requirement shall be included for this project. The Engineer shall make the decision regarding questionable areas of conflict.

E. Existing Conditions: All existing conditions might not be indicated in the design drawings. The installer of each system shall check site and existing conditions thoroughly before bidding and advice the Engineer of discrepancies prior to bid.

F. Coordination: Although design technology drawings were intended to be coordinated with other trades, the fact that installer for other non-technology system might have changes to their design drawings, requires the Contractor to produce coordination drawings for a specific space, including all elements of all trades for space planning and coordination purposes.

1.3 ABBREVIATIONS

A. Abbreviations: The following abbreviations or initials may be used:
   1. ABV CLG - Above Ceiling
   2. AC - Alternating Current
   3. ADA - American Disabilities Act
   4. AFF - Above Finished Floor
   5. AFG - Above Finished Grade
   6. AMP - Ampere

7. ANSI - American National Standards Institute
8. AWG - American Wire Gauge
9. BC - Bare Copper
10. CCTV - Closed Circuit Television
11. CATV - Community antenna television
12. CLG - Ceiling
13. COAX - Coaxial Cable
14. CPU - Central Processing Unit
15. DC - Direct Current
16. DEG - Degree
17. EMT – Electrical Metallic Tubing
18. GND - Ground
19. IDF - Intermediate Distribution Frame (Telecom Room)
20. IMC - Intermediate Metallic Conduit
21. IN - Inches
22. IP - Internet Protocol
23. JB - Junction Box
24. KVA - Kilo-Volt-Amps
25. KW - Kilowatts
26. LBS - Pounds
27. LED - Light Emitting Diode
28. MAX - Maximum
29. MDF - Main Distribution Frame (Main Telecom Room)
30. MIC - Microphone
31. MIN - Minimum
32. MTD - Mounted
33. MTG - Mounting
34. NEC - National Electrical Code
35. NECA - National Electrical Contractors Association
36. NEMA - National Electrical Manufacturers Association
37. NFPA - National Fire Protection Association
38. NIC - Not in Contract
39. OFE - Owner furnished equipment
40. OSHA - Occupational Safety and Health Administration
41. PB - Pullbox
42. PWR - Power
43. PVC - Polyvinylchloride
44. EF - Telecommunications Entrance Facility
45. TR - Telecommunications Room
46. TTB - Telephone Terminal Board
47. V - Volt
48. WP - Weatherproof

1.4 CODES AND STANDARDS

A. Application: The codes, standards and practices listed herein generally apply to the entire project and all technology systems. Other codes, standards or practices that are more specific will be referenced within a particular specification.

B. Requirements: All articles, products, materials, fixtures, forms or types of construction covered in the specifications will be required to meet or exceed all applicable standards of manufacturer, testing, performance, capabilities, procedures and installation according to the requirements of ANSI, NEMA, IEEE, NEC, BICSI and TIA referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents which exceed but are not contrary to governing codes shall be followed.

C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed technology system installation shall be inspected and certified by all applicable agencies that it is in compliance with all codes.

D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements. List of applicable codes:
   1. 2018 International Building Code
   2. 2015 International Fire Code

E. UL Labels: All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. No equipment shall be installed if there is no labeling or listing service is available for such equipment.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. Definitions:
   1. Basis of design: A product or group of products from an identified manufacturer that was used as the basis of systems layouts and installation details, part of the contract documents.
   2. Prototype: Is a product or a group of products that are not yet ready for commercial use because they are in the testing phase (Beta testing) of the product development.
   3. Alternates: Products or manufacturers listed in the contract documents as acceptable compare to the basis of design. Use of alternates shall follow the same system architecture as the basis of design.
   4. Obsolete: A product that has been discontinued by the manufacturer or declared in end of life, and it is no longer being manufactured.
   5. Substitution: A product not listed in the contract documents but capable of similar characteristics as the basis of design operating as a direct replacement in the system in reference. The installers can propose a substitution if all requirements are met as indicated in this specification.
   6. Substitutions that create a change in system architecture are products that create a very different system configuration impacting other trades (i.e. change in power/cooling requirements, changes in raceways layout or sizes, changes in equipment space requirements, changes in low voltage wiring layouts, types and quantities, etc) but providing a similar end result as the system/products basis of design.

B. Use of Prototype. Prototypes are not allowed in any technology system.

C. Use of alternates. Alternates are allowed and installer shall follow these requirements:
   1. Where several brand names make or manufacturers are listed as acceptable alternates each shall be regarded as equally acceptable, based on the design selection. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where three or more manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance.
   2. The use of alternate products does not allow the change of system architecture with such products.

D. Use of substitutions. Substitutions are only allowed when they meet all the requirements below:
   1. Substitutions are only allowed when a particular specification section for a technology system, allows the use of substitutions for that particular system.
   2. The performance of all substitutions components must meet or exceed those of the basis of design. Should an installer wish to submit a substitution product or a product set stated in the construction documents as 'acceptable', it shall be the responsibility of the installer to submit to the Engineer an item-for-item CROSS REFERENCE for all specifications of the product, all related specifications and product data sheets, for the proposed substitution. Use the substitution request form indicated in Attachment 1 of this specification.
   3. The Engineer has the authority to reject a substitution without cause and the installer shall provide the basis of design and no additional compensation.
   4. Substitutions of unnamed manufacturers will not be acceptable.
   5. Certification of substitutions: When a basis of design is specified to be in accordance with a trade association or government standard requested by the Engineer, installer shall provide a certificate that the substitution complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
   6. Substitutions that create a change in system architecture are not allowed [allowed under the following conditions]:
      a. Substitution request for this type of system requires submitting the overall cost of substitution including the cost of changing other systems affected as well as the re-design cost for such systems. Without this information this type of substitution will not be evaluated at all.

1.6 SHOP DRAWINGS AND SUBMITTALS

A. General: Shop drawings shall be submitted for equipment and material as indicated in the individual specification sections for each system. .

B. Quantity of shop drawings submittals: Follow Division 1 requirements for quantity of shop drawings and submitting requirements. If the project does not have a Division 1 specification, shop drawings shall be submitted in quantity of one (1) for electronic format submittal and quantity of four (4) for hardcopies.

C. Electronic submittals. Submittals in electronic format (PDF) are accepted.

D. When cut sheets of products are submitted and the manufacturer cut sheets indicate several model numbers or variations of the same product, the cut sheet shall be highlighted by the installer to indicate the specific product that will be provided for this project. Submittals received with cut sheets indicating multiple parts numbers and not highlighted will be rejected and not reviewed.

E. Equipment and material quantities are not reviewed by the A&E as part of this submittal process. Equipment quantities are to be provided by the installer as indicated in contract documents. Approved shop drawings indicating any changes in equipment quantities or overall scope of work different from contract documents does not constitute approval by the A&E of those changes. The contract documents and any changes issued by the A&E in the form of Supplemental Information during the construction process are always to be followed for equipment quantities and scope of work.

F. All electronic equipment prone to obsolescence and with lead times less than 3 months shall be submitted for approval no sooner than 12 month before the date set for substantial completion of the project. Electronic equipment prone to obsolescence includes devices like flat panel displays, transceivers, servers, players, workstation and routers

G. Equipment and materials installed not in accordance with the approved shop drawings shall be replaced at installer's expense.

H. Multiple stages of shop drawings shall be required as indicated in each specification section. For final completion and testing the installer shall provide a submittal with the following information:
   1. Detailed course syllabus for each type of training required in the specifications
   2. A proposed schedule of training sessions in compliance with the specification sections and indicating place where the training will take place.
   3. A copy of all training material to be used during each session.
   4. Test result sheets for all testing done by the installer prior to the system acceptance test.

PART 2 - PRODUCTS

2.1 IDENTIFICATION AND LABELING TAGS

A. All conduit, cabinets, cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified with pre-printed labels or tags.

B. The only approved types of labels for inside premise environments for any technology systems are:
   1. Non-laminated thermal transfer labels, printed with a high quality thermal transfer printer.
   2. Laminated thermal transfer labels printed with a high quality thermal transfer printer.

3. Thermal transfer polyolefin tape printed with a high quality thermal transfer printer.
4. Self laminated dot-matrix labels, printed with a high quality dot matrix printer.
5. Non-laminated dot-matrix labels, printed with a high quality dot matrix printer.

C. For labeling of cables or equipment in outdoor environments use only marker plates attached to cable or equipment with cable ties. Do not use any labels with adhesive materials. Use different color plates for different cable types. Use only waterproof ink for writing on marker plates.

D. Any type of write-on labels (except for outdoor marker plates), hand writing on cable jackets or directly on equipment, labels made with masking tape or any other type of tape not listed in previous paragraph are not acceptable and shall be corrected with approved labeling methods at no additional cost to the owner.

E. Approved manufacturer:
1. Rhino,
2. Brady,
3. Panduit or
4. approved equal

2.2 TECHNOLOGY EQUIPMENT AND MATERIALS

A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacturer of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear a label as indicated in paragraph 1.4.E. of this section.

B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer and the contract documents.

C. Required Accessories: All equipment specified in the technology systems shall be provided with all required accessories for proper operation and mounting. Typically these accessories are not specifically indicated in the design drawings but shall be provided per this specification section. Such accessories include items such as power supplies, power cords, rack ears, rack rails, bolts, lugs, faceplates, etc.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. WORKMANSHIP: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship.

Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.

B. STANDARD OF QUALITY: To define good workmanship, all installation practices described in BICSI standards shall be followed.

C. PROTECTION OF EQUIPMENT: Equipment for Technology systems shall at all times during construction be adequately protected against mechanical/chemical damage by the elements or work perform by other trades. Equipment shall be stored in dry permanent shelters. If equipment or materials has been damaged, such equipment shall be replaced at no additional cost or time extension to the Contract. Damaged equipment and materials include the following conditions:
   1. Equipment that has visible scratches, cracks or equipment that has paint or finished surface peeled off.
   2. Equipment with visible indication of rust or water intrusion.
   3. Equipment that has dents on the metal enclosures and are clearly visible to the end user.
   4. Equipment that has been sprayed with paint, fire proofing materials, or other type of chemicals, when the equipment was not intended to have this type of materials applied to it, per contract documents.
   5. Equipment that has been burnt by controlled fires, power surges, power sags or by lightning.
   6. Equipment that has a known damage to any parts, electronic board or component, even if such component or board has no specific use in the project.
   7. Cables that have visible damages to the jackets even if cables are not broken and still provide electrical continuity.
   8. Cables sprayed with paints that affect the warranty of the cable as defined by the cable manufacturer.
   9. Equipment with screws with stripped heads.

D. CLEAN EQUIPMENT: All equipment installed in spaces accessible to the building occupants like in racks, cabinets, wall mounted panels, credenzas, etc. shall be free of dust at the time the space part of the project gets the final Certificate of Occupancy and at the time of the acceptance test by the A&E. A clean equipment is defined as an equipment that if wiped with a finger, in any surface, does not leave visible debris and dust in the finger, also equipment with no visible signs of dust inside the equipment, like in ventilation fans.

E. IDENTIFICATION AND TAGGING: All technology systems items shall be labeled and identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system which it serves or controls. Refer to Identification Section of the specifications for additional information. All labels of equipment and wiring shall match the labeling used in the shop drawings for the system.

3.2 COORDINATION

A. General: The installer shall compare shop drawings with those of other trades and report any conflicts between them to the A&E. Obtain from the A&E written instructions

to make the necessary changes in any of the affected work. All work shall be installed in cooperation with other Trades installing interrelated work.

B. Adjustments: Locations of conduit and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of all systems prior to fabrication or installation.

C. Replacement: All work shall be installed in a way to permit removal (without damage to other parts) of all other system components provided under this Contract requiring periodic replacement or maintenance. All conduits shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.

3.3 REQUEST OF IP ADDRESSES

A. General: When contract document require the installer of any of the technology systems to use IP addresses for the configuration of such system, inside the owner's controlled IP network, the installer shall request the owner to provide such IP addresses. The installer shall request such information no less than one (1) month in advance from the moment the installer will be programming the system and by using the form named "Network Connections Programming Plan" indicated in Attachment 3 of this specification. An electronic copy of this form is available upon request from TLC Engineering.

B. Completing the form. The Network Connections Programming plan shall be completed in separate by each trade that requires IP addresses. This form has two parts. The first part indicates all the different device types for a system (i.e. cameras, workstation, servers, controllers, VoIP phones, etc). The second part is a list of all devices required classified by their type and properly indicating location where the device will be used.

C. Request that do not follow this process, or have incomplete information will be ignored and will not be processed.

D. Reprogramming cost of any technology systems due to un-approved addresses used by the installer shall be at the installer's expense

3.4 TELECOM ROOM/EQUIPMENT ROOM READINESS

A. In any projects where the technology systems require the use of network equipment (switches, routers, firewalls, etc) provided by the owner, the Contractor shall complete all telecom rooms to a point where they are suitable for the owner to deploy such equipment in those rooms. At a minimum the following conditions shall be meet at all rooms in order for the owner to install the equipment:
   1. All power outlets in the telecom rooms shall be fed from the permanent source of power. Temporary power shall not be provided.
   2. Backup power (generator and/or UPS) shall be already operation, tested and connected to the final power distribution system.
   3. The mechanical equipment providing the cooling for the telecom rooms shall be fully operational. Temporary cooling shall not be accepted.

4. Fire suppression system (sprinkler or gas based system) protecting the telecom rooms shall be fully operational and tested.
5. All light fixtures in the telecom rooms shall be fully operational.
6. All walls to the telecom rooms shall be completed and including the last coat of paint.
7. The ceiling and flooring of the telecom rooms shall be finished.
8. All horizontal and backbone cabling system part of the structured cabling system (SCS) shall be installed, terminated and tested.
9. The final and permanent doors to the telecom rooms shall be installed with a key core different from all other construction cores in the site.
10. Telecom rooms shall be cleared of any materials being stored inside the room.
11. Telecom rooms shall be clean. Clean will be measured as not having any debris left in the room and not having dust in rack, cabinets, or wall mounted panels. If wiping a finger in any of the surfaces of such equipment leaves visible dust residue in the finger, the room will not be considered clean.
12. Hallways and rooms leading into the telecom rooms shall have no more sanding to be done in the walls and the floor shall be completed to avoid dust from these spaces moving into the telecom rooms.
13. Prior to the owner deploying the equipment in these rooms, the Contractor shall provide disposable sticky mats at the entrance of each telecom room to capture dust and/or dirt from people's shoes or boots coming into the room. The sticky mats shall be selected as to cover the width of the door opening. Sticky mats shall contain no less than 60 sheets in each unit. Used sheets of the mats shall be replaced no less than on a daily basis or if worn out before the end of the day. Sticky mats shall be provided until the project receives the final Certificate of Occupancy.

B. In projects where the network equipment is part of the contract documents, the contractor is required to provide all equipment functioning and clean at the end of the project. The contractor is responsible to determine at what point this delicate equipment can be installed in the telecom room. The contractor shall make sure the recommended manufacturer guidelines are applied to the installation of the equipment when it comes to cleanness. It is highly recommended that all steps indicated above are followed even for this type of project.

3.5 SYSTEMS WARRANTY AND SERVICE

A. General: At a minimum all technology system shall include a warranty from the manufacturer and installer of the system for no less than one (1) year with the following exceptions:
   1. Structured Cabling system shall have a warranty longer than one year as indicated in that specification section.
   2. When specific equipment or software manufacturers include a warranty longer than one year, the manufacturer's warranty shall be transferred to the owner in the same terms as indicated by the manufacturer.

B. Warranty coverage. The warranty for the technology system shall cover the following elements:
   1. All equipment parts, cabling and materials.

2. Any software updates/patches issued during the warranty period by the manufacturer.
3. The labor to replace those parts and programming time to re-configure equipment.
4. Shipping and freight charges to send equipment back and forth from the manufacturer and/or site.
5. Tool rentals such as scaffold or lifts to access equipment.
6. The troubleshooting time to detect the faults in the system.
7. All travel time and expenses associated with the service.

C. Start of warranty. The warranty period for the technology systems starts the day the project gets the Certificate of Occupancy (CO), for new construction projects. For retrofit jobs of a particular system, the warranty starts when the project is accepted by A&E. For most equipment/software manufacturer's the warranty period starts when the equipment is shipped from the factory, so it is the responsibility of the installer of each system to provide additional warranty coverage from the manufacturer to cover the additional time of warranty up to the CO date plus one year.

D. Service calls. During the warranty period the installer shall support the system when called by owner/contractor for service. All equipment/software service shall be done by personnel with the same qualifications as the personnel who installed the system and as indicated in each technology system specification section. Service calls shall be taken during business hours (same time zone as the project) for normal service and twenty (24) hours three hundred and sixty five (365) days in the year for emergency service. Emergency Service shall be defined as the loss or failure of any critical component necessary to maintain the overall integrity and operation of the system. Normal service shall be defined as the loss or failure of a system component that does not compromise the complete operation of the system and allows the owner to operate the system at a minimum of 90% of its capacity. See individual specification sections for delineation on critical components and normal service.

E. Response time for service. The maximum allowed response time after a service call for emergency service shall be four (4) hours and for normal service twenty four (24) hours.

F. Equipment registration. All equipment/software part of the technology system shall be registered to the owner with the manufacturer of the equipment/software for warranty and support. Equipment/software registered with the manufacturer to the name of the Contractor or installer shall be removed from the project and replaced with equal equipment registered to the owner at no additional cost to the owner.

G. Periodic preventive maintenance visits. During the warranty period the installer of the system shall provide no less than two (2) preventive maintenance services. These services shall be provided at 6 months from start of the warranty period and a few weeks before the end of the warranty period. The installer of the system shall coordinate with the owner the precise dates for this type of service. During these visits the following task shall be perform:
1. Clean up of any active equipment that shows visible accumulation of dirt, dust of debris of any kind.

2. Replacement of any consumable parts in the system that require replacement per manufacturer's instructions during the warranty period, such as filters.
3. Oiling/greasing of any mechanical parts that require period maintenance as per manufacturer's instructions during the warranty period.
4. Run manufacturer's recommended test for each piece of equipment installed. The installer shall provide at the end of the service a report of such test.
5. Visual observation of all devices in the system to spot any anomalies.
6. Review of error logs from any system components and analysis of such logs with explanation to owner on the cause of those errors.

H. Extended service agreement. Prior to final acceptance testing, and within thirty 30-days of project com shall include, at a minimum, the same provisions as during the warranty period.

3.6 COMMISSIONING

A. This project will be commissioned by the A&E or by a third party company designated by the owner. The commissioning process will consist of a third party testing by the commissioning agent of a percentage of the installed infrastructure.

B. The installer of each system shall notify the owner when the project is ready for commissioning. The installation is ready for commissioning once the installer is complete with the testing of the system and the identification process has been completed.

C. The installer shall be available on site to resolve any results discrepancies between the test results provided by the installer of the system and the commissioning agent.

3.7 ENGINEER'S FINAL ACCEPTANCE TEST

A. The technology systems shall be tested during installation by the installer as frequently as required to solve any installation issues and non compliance of system specifications. Technology systems will not be considered delivered to the owner until final acceptance test is passed. The final acceptance test shall be done in presence of the A&E and/or the owner. The installer shall request in writing with 2 weeks in advance the presence of the A&E and/or owner for the final acceptance test.

B. In order for the installer of the system to request final acceptance the following task shall be completed:
1. All components shall be inspected to ensure they have been properly installed by the installer, securely attached, and remain clean and unmarred
2. All equipment shall be properly adjusted, clearly labeled, and fully operational.
3. The installer shall have tested the system previously to ensure the final acceptance test will be successful. Detailed proof of test shall be sent to the A&E with the request for final acceptance
4. All permanent and final labels as requested in the identification and tagging section of this specification are completed.
5. No temporary conditions shall be present in the system.
6. All batteries on all system components shall be connected.

7. All system programming shall be completed as indicated in the specification for each technology system.

C. All test equipment required for the Final acceptance shall be provided by the installer of the system unless specifically indicated by the A&E.

D. The A&E shall define the scope of the testing but the installer shall be prepared for testing every single component of the system. During the day of the test the A&E will indicate the testing process and procedures for each system. Test could include operation of the system during power outages. The installer of the system shall be available during the complete testing process to answer questions from the Engineer and to demonstrate specific parts of the system. If personnel form the installer or test equipment is not available, the test will be considered and marked as a failure.

E. A punch list of the items to be corrected will be prepared by the A&E during the final acceptance test. The installer shall correct all items and request a second day for verification of all punch-list items by the A&E and Owner. During the second test, no additional punch list items shall be expected, and only the items in the punch list will be tested.

F. If during the testing process the A&E and/or Owner consider that the rate of failure of the test is too high (more than 5 failures or non-compliance with specifications in one hour of test), the test will be cancelled unilaterally by the A&E and/or owner. The installer shall correct all items and re-schedule the final acceptance test again. The new test will start over from the beginning and nothing previously tested will be accepted. The installer shall not be entitled to additional compensation for the additional effort to test the system during this condition. To the contrary, the Contractor/Installer shall reimburse the owner of the project with the cost of the additional hours of testing required to be spent by the A&E and owner's team. The rate to be used for this reimbursement will be $150 per hour per person required by the A&E and Owner to complete the test. [Do not use this paragraph on DB projects]

G. Upon successful completion of the final acceptance test the installer of the system will receive a written notice by the A&E and/or Owner acknowledging the acceptance of the test

H. See individual specification sections for system specific requirements for testing.

3.8 TRAINING AND INSTRUCTION

A. Training for each technology system shall be provided as indicated in this specification and in the individual specification section for each system.

B. The following training guidelines shall be followed for all technology system
1. Training shall not be scheduled in a way that no attendee or presenter shall be required to attend more than 6 hours of training per day.
2. Prior to starting all training, the training submittal shall be approved. See section one of this specification for details on the training submittal

3. No training shall be scheduled prior to the system being completed and accepted by the A&E.
4. Training shall be conducted during normal business hours of the client, at a date and time of mutual convenience to the Owner and installer. All training sessions need to be scheduled by the installer at least 2 weeks in advance. The Owner shall be notified in writing by the installer on when are the possible dates for each session.
5. All different types of training shall be videotaped and delivered to the owner as part of the close out information in digital copy. All tapes shall be recorded in hi-quality MPEG2 or HD recorders, and the media turned to the owner shall be in electronic format viewable through QuickTime or Windows Media Player.
6. The installer is responsible for completing list of attendants for each session of training. All these sheets shall be submitted as part of the close out information

3.9 AS BUILT DOCUMENTS

A. Production: During the course of this project the contractor shall maintain record "as-built drawings". One set shall be maintained at the site and at all times and it shall be accurate, clear, and complete, showing the actual location of all equipment as installed. The "As-Built" drawings shall show all technology systems work installed complete to the present stage of progress. These drawings shall be available for review by the A&E's field representatives at all times.

B. Completion: At the completion of the Work, transfer onto the second set of drawings all changes marked in colored and submit to the A&E.

C. Final: Upon installer’s completion of the Engineer's final punch list, transfer all "As-Built" conditions and all requirements by the Engineer to a reproducible set of drawings. Submit full size drawings and one (1) set of CAD/Autodesk Revit© disks for review and acceptance.

D. Additional documents. At project completion, the installer of the technology system shall provide, as part of the as-built documents, updated tables, equipment schedules, configuration worksheets and labeling system used. See individual system specification section for more details on these documents.

E. See individual specification sections for each system for additional requirements for As-Built documents.

3.10 CLOSE OUT DOCUMENTS

A. Closeout information shall be provided to the owner in electronic format at the end of the project. The file shall be organized by each system and shall follow this organization:
   1. PART 1 – OPERATION AND MAINTENANCE MANUALS. Operation and Maintenance manuals as issued by the manufacturer of each system’s component. Such manuals shall include all maintenance procedures required to

be done by the owner. Also, when required by each individual specification section, a short form operation guide, prepared by installer) for the system.

2. PART 2 – INVENTORY OF EQUIPMENT INSTALLED. A detailed list of all relevant active equipment (equipment with electronic components with a market value over $200) installed in the project including the following information and presented in electronic format (Microsoft Excel):
    a. Make
    b. Model
    c. Serial number
    d. Room location
    e. Warranty period, including manufacturer's extended warranties.
3. PART 3 – PROOF OWNERSHIP, DELIVERY AND ACCEPTANCE. The following letters/documents shall be attached in this part:
    a. Acceptance letter signed by A&E for each of the technology systems installed.
    b. Proof of training by submitting sign in sheets for each training session done
    c. Signed transmittal for all training videos and training material.
    d. Signed transmittal for all spare parts and consumables delivered to the owner.
    e. A list of all the user names and passwords for all the different software programs used by the technology systems and any equipment with password codes. All levels of passwords shall be provided, from the lowest hierarchy to the highest.
    f. At least four (4) copies of all physical keys to different devices part of the technology systems. Each key shall be individually tagged in a key ring. All keys shall be included and organized inside a key ring management enclosure.
    g. A list of all software modules and licenses delivered to the owner. The list shall include part numbers, serial numbers, license certificate of authenticity, hardware key (dongles) numbers, and software version. This list shall have a clear signature, name and date on person that received this software by the Owner.
    h. A copy of all official equipment and software registrations with manufacturer.
4. PART 4 – AS BUILT DOCUMENTS. All as-built documents as indicated in this specification section

END OF SECTION 27 00 10

ATTACHMENT 1 – SUBSTITUTION REQUEST FORM

Substitution Request Number: ___

PROJECT:_____ DATE: ___

SPECIFICATION SECTION: _____ITEM(S):___

SPECIFIED MANUFACTURER:_____

SPECIFIED MODEL NO: _____

PROPOSED MANUFACTURER:_____

PROPOSED MODEL NO:_____

REASON(S) FOR NOT PROVIDING SPECIFIED ITEM:_____

Attach product description, drawings, photographs, performance and test data, samples and other information necessary for side-by-side evaluation. Fill in all blanks.

A. Provide substantiated reason for requested substitution.

B. Does the requested substitution affect dimensions, locations or configurations?
No:_____Yes:___
Explain (attach drawings if necessary):_____

C. What are the differences between the specified item and the requested item:

D. Will the Contractor pay for any changes to the building design, including engineering and detailing costs caused by the approval?
No:_____Yes:___
Explain (if no, and describe modifications required to install or accommodate the requested change):_____

E. W
ill approval affect the work of other trades, including the Construction schedule?
No:_____Yes:___
Explain (if yes):_____

F. M
anufacturer's guarantees of the proposed and specified items are:
Same:_____Different:___
Explain (if different):_____

G. D
oes the proposed item meet all applicable codes, ordinances and regulations for this specific application?
No:_____Yes:___
Explain (if no):_____

H. H
as proposed item been used locally in similar applications?
No:_____Yes:___
Explain (give nearest location):_____

I. W
ill maintenance and service parts be locally available for the requested item?
No:_____Yes:___
Explain (if no, give nearest location):_____

J. W
ill the requested item require waiving of any qualifications or other requirements?
No:_____Yes:___
Explain (if yes):_____

K. A
re there any license fees or royalties associated with the requested substitution?
No:_____Yes:___

Explain (if yes):_____

L. If approved, will the Owner receive a credit for the proposed alternate material?
No:_____Yes:____
Explain (if no):_____

M. Does the proposed alternate material meet the same applicable standards (ASTM, ANSI, UL, FS) as the specified item?
No:_____Yes:____
Explain (if no, attach drawings if necessary):_____

N. Identify the recycled materials or components or features that lead to the claims to being "Green": _____

O. Has the required line-by-line comparison been included?
No:_____Yes:____
Explain (if no):_____

The undersigned agrees to pay for the Designer's review time and for changes to the building design, including review, re-design, engineering, drawings and other costs caused by the requested substitution.

Signature

Print

The following Purchase Order or billing number is to be used for billing the Contractor for costs incurred in evaluating and if applicable accommodating the requested substitution.

The Engineer will not be required to approve any product that is not equal or suitable for the specific application and functionality of this project.

ATTACHMENT 2 – RESPONSIBILITY MATRIX

DESIGN AND CONSTRUCTION RESPONSIBILITIES					
ITEM	SYSTEM	SCOPE	DESIGN RESPONSIBILITY	PROCUREMENT RESPONSIBILITY	CONSTRUCTION RESPONSIBILITY
1.00	VOICE SYSTEM (TELEPHONE COMMUNICATIONS SYSTEM ALL AREAS)				
1.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
1.02	INSIDE PREMISE WIRING	Structured cabling system	TLC	CM	CM
1.03	OUTSIDE PREMISE WIRING IN PRIVATE CAMPUS	Structured cabling system	TLC	CM	CM
1.04	OUTSIDE PREMISE WIRING FROM SERVICE PROVIDERS	Fiber and copper for services	TLC/Owner	S.P.	S.P.
1.05	PATCHING OF VOICE LINES	Patching at path panel and work areas	TLC	N.A.	OWNER
1.06	PHONE SWITCH	Equipment selection, sizing, equipment layout, RFP	OWNER	OWNER	OWNER
2.00	DATA SYSTEM (COMPUTER NETWORKS ALL AREAS)				
2.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
2.02	INSIDE PREMISE WIRING	Structured cabling system	TLC	CM	CM
2.03	PATCHING OF DATE LINES LINES	Patching at path panel and work areas	TLC	N.A.	OWNER
2.04	ACTIVE ELECTRONICS (NETWORKING EQUIPMENT, SWITCHES, ROUTERS, SERVERS AND COMPUTERS)	Equipment selection, sizing, equipment layout, RFP	OWNER	OWNER	OWNER
3.00	TELECOM ROOM OUTFIT				
3.01	PLYWOOD AND WALL SLEEVES	Plywood and sleeves for cables	TLC	CM	CM
3.02	GROUNDING SYSTEM	Bround bar and ground bass	TLC	CM	CM
3.02	RACKS, WIRE MANAGERS AND LADDER TRAY	Racks and all passive elements	TLC	CM	CM
4.00	CATV DISTRIBUTION (CABLE TV FOR ALL AREAS)				
4.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
4.02	INSIDE PREMISE WIRING	Coaxial cable	TLC	CM	CM
4.03	DISTRIBUTION DEVICES	TAPS, amplifiers, splitter, DC	TLC	CM	CM
4.04	TVS IN PATIENT ROOMS	TVs not part of the system	MEP	OWNER	CM
4.05	MOUNTS FOR TVS	Mounts for the TVS	MEP	OWNER	CM
5.00	AV SYSTEMS/ PAGING				
5.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
5.02	INSIDE PREMISE WIRING	AV wiring for systems	TLC	CM	CM
5.03	ACTIVE ELECTRONICS	Projectors, presentation control system, paging system, etc.	TLC	CM	CM
6.00	SECURITY SYSTEMS, BUILDING CCTV AND ACCESS CONTROL				
6.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
6.02	INSIDE PREMISE WIRING	Cables for cameras and card access	TLC	CM	CM
6.03	ACTIVE ELECTRONICS	Cameras, DVRs, Access control panels, readers, etc	TLC	CM	CM
6.04	LOCKING DEVICES	Magnets, electric mortise locks	Architect	CM	CM
7.00	EMERGENCY POWER BACKUP (UPS) FOR ACTIVE EQUIPMENT				
7.01	POWER WIRING	Conduit, cables and circuits	TLC	CM	CM
7.02	ACTIVE EQUIPMENT - SMALL UNITS	UPS units in racks or in work areas	OWNER	OWNER	OWNER
7.03	ACTIVE EQUIPMENT - LARGE UNITS	Central UPS system	TLC	CM	CM
8.00	FIRE ALARM AND BUILDING MANAGEMENT SYSTEM				
8.01	RACEWAYS & WIRING	Conduit, cables, patch panels, cable tray outlets, etc	TLC	CM	CM

DESIGN AND CONSTRUCTION RESPONSIBILITIES					
ITEM	SYSTEM	SCOPE	DESIGN RESPONSIBILITY	PROCUREMENT RESPONSIBILITY	CONSTRUCTION RESPONSIBILITY
8.02	ACTIVE ELECTRONICS	Data gathering panels, sensors, etc	TLC	CM	CM
9.00	**DISTRIBUTED ANTENNA SYSTEM**				
9.01	RACEWAYS & WIRING	Conduit, cables, patch panels, cable tray outlets, etc	TLC	CM	CM
9.02	INSIDE PREMISE WIRING	Cable , grounding	VENDOR	VENDOR	VENDOR
9.01	ACTIVE ELECTRONICS	Head end system and antennas	VENDOR	VENDOR	VENDOR
10.00	**MEDICAL EQUIPMENT**				
10.01	RACEWAYS & WIRING	Conduit, cables, patch panels, cable tray outlets, etc	TLC	CM	CM
10.02	WIRING FOR SYSTEMS USING SCS	SCS cable components	TLC	CM	CM
10.03	ASY FOR SCS CABLE	SCS cable components	VENDOR	VENDOR	VENDOR
10.01	ACTIVE ELECTRONICS, PIXIS, TELEMETRY, DICTATION, PATIENT MONITORING	Head end system and antennas	VENDOR	VENDOR	VENDOR

TLC ENGINEERING SOLUTIONS

NETWORK CONNECTIONS PROGRAMMING PLAN

PROJECT NAME	
DATE	

SUBCONTRACTOR	
TRADE	

TYPE OF DEVICES FORM (Fill one column per device type provided)

DEVICES CHARACTERISTICS	**DEVICE NAME**		**DEVICE NAME**		**DEVICE NAME**	
	DEVICE CODE	**A**	**DEVICE CODE**	**B**	**DEVICE CODE**	**C**
Manufacturer						
Part Number						
Firmware version						
Is a fixed address required or can device work with a dynamic address (DHCP)?						
Does device require an address from a DNS server?						
Does device support Layer 3 traffic (IP)?						
Does device needs access to the internet?						
Number of physical network ports per device?						
Does device require IPv6 to work or IPv4?						
Does device support SNMP?						
Does device need specific TCP ports open? Please list						
Is this device connecting to existing network devices (Yes/no) Server/client application						
If yes to above, please describe to what device, located where.						

TLC ENGINEERING SOLUTIONS

NETWORK CONNECTIONS PROGRAMMING PLAN

PROJECT NAME	
DATE	

SUBCONTRACTOR	
TRADE	

LIST OF DEVICES FORM (Fill one entry in form per each device being provided

DEVICE PHYSICAL LOCATION BUILDING AND ROOM #	DEVICE CODE FROM PREVIOUS FORM	DEVICE NETORK NAME	IP ADDRESS	SUBNET	GATEWAY	DNS SERVER	VLAN NAME

Filled out by Network administrator

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SECTION 27 05 26 - GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section.

B. General: For grounding electrode system and equipment grounding system for Telecommunications refer to specification section 260526. In all cases the applicable electrical codes for grounding and bonding for telecommunications shall be met.

C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 27 00 10 Technology General Provisions
   2. 27 05 28 Raceways for Technology
   3. 26 05 26 Grounding and Bonding for Electrical Systems

D. General. For a bonding diagram for telecommunications refer to T Drawings.

E. General. The bonding approach required herein is intended to work in concert with the cabling topology as specified in Specification section 271000 and installed in accordance with specification section 270528.

F. Reference Standards:
   1. TIA-607-D
   2. TIA-568.0-D
   3. TIA-606-C
   4. UL 1863 Communication Circuit Accessories
   5. UL-50 & UL-514
   6. NFPA 70 – NATIONAL ELECTRIC CODE
   7. IEEE Std. 1100-1992, Powering and Grounding Sensitive Electronic Equipment.
   8. BICSI TDMM, Telecommunications Distribution Method Manual.
   9. UL 1449
   10. NFPA 780
   11. R56 “Standard and Guidelines for Communications Sites” Motorola Inc. 2005.

G. Standard compliance: This project requires compliance with R56 grounding standards. The requirements of R56 grounding standards are more stringent and supersede the requirements indicated in this specification section.

1.2 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 27 00 10 are followed.

1.3 SHOP DRAWINGS AND SUBMITTALS

A. See additional requirements for shop drawings and submittals in specification section 27 00 10.

B. The installer of the Telecommunications Grounding systems shall provide the following information in the shop drawings phase of the project:
   1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
   2. A spreadsheet indicating telecommunications ground bar information selection for each telecommunications room indicated in the design drawings, including the following information:
      a. Room Name or number
      b. Quantity of ground bars
      c. Height of each ground bar
      d. Length of each ground bar
      e. Number of holes in each ground bar
      f. Label for each ground bar
   3. A drawing indicating the following information:
      a. Location of all telecommunications ground bars and routing of all telecommunications grounding backbones.
      b. Wire size charts for all telecommunications grounding backbones in the project.
      c. All labels to be used in telecommunications backbone cables, bonding conductors and telecommunications ground bars.
   4. A detailed drawing layout of the MCBN for all spaces with raised floor in the project

1.4 ABBREVIATONS

A. General: The following abbreviations are used in this specification section:
   1. TBB - Telecommunications Bonding Backbone
   2. BC - Bonding Conductor
   3. EMT - Electrical Metallic Tubing
   4. RMC - Rigid Metal Conduit

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

A. The TMGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB shall be located and provided in the Main Telecommunication Room in each building. The TMGB must also be listed by a nationally recognized testing laboratory (NRTL).

B. The TMGB shall have the following specifications:
   1. Material: Copper with a thin platted finish.
   2. Thickness: ¼" thick
   3. Width: No less than 4"
   4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 14" long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
      a. Two holes required for each TBB termination.
      b. Two holes for each cabinet or rack row in the room
      c. Two holes for each protector block in the room
      d. Two holes for each layer of ladder tray above the rack.
      e. Two holes for each set of conduit sleeves entering the room
      f. 20% of spare capacity shall be available after all terminations are done.
      g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.
   5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16"
   6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.

C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.

D. Approved manufacturers:
   1. Panduit,
   2. Erico, or
   3. Approved equal.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR INTERIOR USE

A. The TGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TGB shall be located and provided in each telecommunication room (except the main telecommunication room) in each building and any other additional locations as indicated in the drawings. The TGB must also be listed by a nationally recognized testing laboratory (NRTL).

B. The TMGB shall have the following specifications:
   1. Material: Copper with a thin platted finish.
   2. Thickness: ¼" thick

3. Width: No less than 4”
4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 12” long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
    a. Two holes required for each TBB termination.
    b. Two holes for each cabinet or rack row in the room
    c. Two holes for each protector block in the room
    d. Two holes for each layer of ladder tray above the rack.
    e. Two holes for each set of conduit sleeves entering the room
    f. 20% of spare capacity shall be available after all terminations are done.
    g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.
5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16”
6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.

C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.

D. Approved manufacturers:
1. Panduit,
2. Erico, or
3. Approved equal.

2.3 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR OUTDOOR USE

A. When TGB are located outdoors, all specs for indoor used TGB shall be followed with the exception of the construction material. The TGB for outdoor use shall be made of galvanized steel.

2.4 FLEX CONDUCTOR, ONE-HOLE, LONG BARREL WITH WINDOW LUG

A. All BCs (different from TBB) shall be terminated in a flex conductor, one hole, long barrel with window lug when a two hole connector is not possible to be used because receiving equipment does not support the two holes. All lugs shall be selected to match the size of the conductor being used. Other types of terminations such as screw type connectors are not accepted

B. The flex conductor, one hole, long barrel with window lug shall have the following specification:
1. Finish: Thin platted
2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
3. Stud hole size: ¼”
4. Barrel type: Long barrel > 1”
5. Termination type: crimp type
6. Angle: straight or angled if installation space is limited.

7. Listing: UL listed and tested to 35 KV and 90ºC

C. Approved manufacturers: Panduit, Thomas & Betts or approved equal.

2.5 FLEX CONDUCTOR, TWO HOLE, LONG BARREL WITH WINDOW LUG

A. Flex conductors, two hole, long barrel with window shall be used with TBB and BCs to provide a good bond. All lugs shall be selected to match the size of the conductor being used. Other types of termination are not accepted.

B. The flex conductor, two hole, long barrel with window lug shall have the following specification:
   1. Finish: Thin platted
   2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
   3. Stud hole size: ¼”
   4. Hole spacing: to match spacing of pre-drilled holes in ground bar or equipment.
   5. Barrel length: long barrel > 1”
   6. Termination type: crimp type
   7. Angle: straight or angled if installation space is limited.
   8. Listing: UL listed and tested to 35 KV and 90ºC

C. Flex conductors, two hole, long barrel with window shall be used with BCs in the following cases:
   1. Bonding two sections of pathways such as sections of tubular runways or cable trays.
   2. Bonding a BC or a TBB to a TGB or TMGB
   3. Bonding to equipment that requires two holes for bonding.

D. Approved manufacturers:
   1. Panduit,
   2. Thomas & Betts, or
   3. Approved equal.

2.6 HTAP CONNECTOR

A. When a BC is required to be bonded to another BC of same or different size the only approved method of bonding is with HTAP style crimp connectors. Screw type connectors, wire nuts or any other method are not acceptable. The specifications of the HTAP connectors are:
   1. Finish: Thin platted
   2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
   3. Tap grooves: installer to select HTAP connector based on size of BCs and quantity of BCs to be bonded.
   4. Slots: The HTAP connector shall have a lot to support the unit to the bonding conductors with nylon cable ties for initial support before crimping.
   5. Termination type: crimp type

6. Listing: UL listed and tested to 600V

B. Approved manufacturers:
   1. Panduit,
   2. Thomas & Betts, or
   3. Approved equal.

2.7 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

A. Telecommunications bonding backbones shall be provided as indicated in the design documents. TBBs shall be insulated copper stranded conductors with a wire gauge dictated by the length of the cable. The TBB shall be sized at 2 kcmil per linear foot of conductor length up to a maximum of 3/0 AWG. The following table shall be used to estimate the size of the TBBs:

TBB length linear m (FT)	TBB Size (awg)
Less than 4 (13)	6
5- 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8– 10 (27 – 33)	2
10– 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
Greater than 20 (66)	3/0

B. Once a TBB has been sized with a particular gauge, any extensions of such backbone shall not be done with a wire gauge smaller than the previous run regardless of distance.

2.8 BONDING CONDUCTOR (BC)

A. Boding conductors shall be used to bond equipment and raceways to the telecommunications grounding infrastructure. The specifications of the BC are:
   1. Conductor Size: use the chart above for TBB to estimate the size of the bonding conductor. BC shall be no smaller than an AWG-6. For projects with R56 Grounding compliance, BC shall be no smaller than AWG-2.
   2. Material: copper stranded conductors.
   3. Insulation: Use non-insulated conductors only under raised floor spaces. Insulation color shall be green with a yellow stripe.

B. Pre-fabricated BCs or field made BCs are acceptable.

C. Both ends of a BC shall be terminated in long barrel lugs.

2.9 RAISED FLOOR BONDING CLAMP

A. Raised floor bonding clamps shall be used to bond BCs under the raised floor to raise floor pedestals. The specifications of the raised floor bonding clamp shall be:
   1. Construction: solid metal device
   2. Bonding of BCs: The device used to bond the BCs shall be a split screw copper bolt sized to match the size of the BCs being bonded
   3. Bonding of raised floor pedestals: The device shall include an adjustable clamp to bond the pedestal. The installer of this system is responsible for selecting the size of the clamp to match the size and shape of the pedestal provided for this project.
   4. Listing: UL listed

B. Approved manufacturers:
   1. Panduit,
   2. Thomas & Betts, or
   3. Approved equal.

2.10 MESH COMMON BONDING NETWORK (MCBN)

A. A Mesh Common Bonding Network (MCBN) shall be provided under all raised floor spaces in the project. The MCBN is basically a grid of non-insulated BCs running under the raised floor. The MCBN shall include a loop around the perimeter of the raised floor. The details of the construction of the MCBN shall be:
   1. Size of conductors: Conductors shall be sized using the table provided in this specification to size the TBB but conductors shall not be larger than 1/0 AWG.
   2. Spacing of the grid: The grid of conductors shall have a spacing no longer than 10’. Below each row of cabinets, racks or consoles there shall be a conductor part of this grid.
   3. Continuous conductors: Each grid line of conductors shall be a continuous conductor without any splices.
   4. Aligning: All grid lines shall be adjacent to the raised floor pedestals to be able to bond the pedestals.
   5. Elevation: All conductors, part of the MCBN, shall not be resting or touching the floor slab. They should be mounted around half of the height of the raised floor pedestals.
   6. Bonding: Bonding shall be provided to the MCBM at the following locations:
      a. Each pedestal with one or more BCs adjacent to it, shall be bonded using a raised floor bonding clamp.
      b. All metal equipment under the raised floor shall be bonded to the MCBN such as cable trays or conduits.
      c. All ground bars above the raised floor and inside the same room shall be bonded to the MCBM with a BC of equal size as the largest conductor in the MCBN
   7. Listing: All bonding equipment used for the MCBN shall be UL 467 listed.

B. Racks, cabinets and consoles above the raised floor shall be individually bonded to the MCBN with a non-insulated BC, if space below raised floor is being used for air

handling. An insulated BC shall be used if the space below the raised floor is not being used for air handling.

2.11 LABELS FOR TELECOMMUNICATIONS GROUNDING INFRASTRUCTURE

A. Installer shall follow labeling materials indicated in specification section 27 00 10.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES.

A. General: Specification section 260526 applies to work of this section. Installation requirements specified herein takes precedence over specification section 260526.

B. General: All installation requirements indicated in specification section 270010 shall be followed.

C. PROTECTION. The TBBs and BCs shall be installed and protected from physical and mechanical damage.

D. GALVANIC CONTINUITY. The TBBs and BCs shall be continuous and routed in the shortest possible straight line path.

E. CRIMPING. All lugs shall be crimped with the proper die for the size of lug being used.

F. PAINT REMOVAL. Paint shall be removed before attaching any BC to an equipment with paint in the surface, such as ladder trays and racks, if no ground lug is available in the equipment.

G. SPLICING. The TBBs and BCs shall be installed without splices. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located within telecommunications spaces. Joined segments of a TBB or BC shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.

H. BONDING TO ELECTRICAL PANELS. The TGB or TMGB shall be as close to the electrical power panel as is practicable and shall be installed to maintain clearances required by applicable electrical codes. The electrical power panel bus or the panel enclosure feeding telecommunications equipment racks/cabinets shall be bonded to the TGB or TMGB.

I. BONDING TO BUILDING STEEL. All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose.

J. LUG SCREWS. All connections from lugs to ground bars or grounding equipment shall be done with metal screws with nuts and compression washers. Connections made with metal self tapping screws will not be allowed.

K. BONDING PROTECTOR BLOCKS. All primary or secondary building entrance protectors' blocks shall be bonded to the nearest TMGB or TGB with a BC. A minimum of 300 mm (1 ft) separation shall be maintained between this insulated conductor and any dc power cables, switchboard cable, or high frequency cables, even when placed in rigid metal conduit or EMT.

L. BONDING OUTSIDE PLANT CABLES. When the outside plant cables in the Telecommunications Entrance Facility room incorporate a cable metallic shield (armor) isolation gap, the cable metallic shield on the building side of the gap shall be bonded to the TMGB or TGB or the rack/cabinet or the rack's vertical ground bar (if available).

M. BONDING BACKBONE CABLES. Where backbone cables (fiber or copper) incorporate a shield (armor) or metallic member, this shield or metallic member shall be bonded to the TMGB or TGB or rack/cabinet or the rack's vertical ground bar (if available).

N. BONDING HORIZONTAL CABLES. When shielded horizontal cable is used and terminated in patch panels, each patch panel needs to be bonded to the telecommunications grounding systems. A BC shall be used between each patch panel and the rack rails of the rack/cabinet or the rack's vertical ground bar (if available).

O. INTENDED USE OF TBB OR BC. The TBB or BC is not intended to serve as the only conductor providing a ground fault current return path. The intended function of the TBB or BC is to equalize potential differences between telecommunications systems.

P. INSTALLATION OF TBBs INSIDE TELECOMMUNICATIONS SPACES. When TBBs are run inside telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs inside telecommunications spaces can be made of PVC and shall be sized and supported as required by NEC.

Q. INSTALLATION OF TBBs OUTSIDE TELECOMMUNICATIONS SPACES. When TBBs are run outside of telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs outside telecommunications spaces shall be EMT or RMC. To avoid an electromagnetic choke effect in this conductor, each end of the conduit used to protect the TBB shall be bonded to the TMGB or TGB at each end. Conduit used for protection of TBBs shall be sized and supported as required by NEC.

R. HALO GROUND SYSTEM. For room with R56 grounding requirements, a halo ground shall be provided around the room. This halo ground is composed of a AWG-0 uninsulated stranded copper conductor, installed 6" below the ceiling, going around the complete perimeter of the room and one end bonded to the TGB in that room. This conductor shall be separated from the wall with 6" plastic stand offs. All metal structures or parts around the room, such as door frames and windows, mechanical cooling equipment, conduit sleeves, etc. shall be bonded to this conductor with a compression connector.

S. RACK/CABINET BONDING. All racks/cabinets in the project shall be bonded to the nearest TMGB or TGB inside the room. All rows of rack/cabinets shall be bonded together by a single AWG-2 conductor coming from the nearest TMGB or TGB inside

the room. This bonding conductor shall be insulated and run above the racks in the side of the cable tray system, going above the racks, supported by a hanger external to the cable tray. At each rack a bonding jumper (AWG-6) shall be provided and terminated to the rack manufacturer's recommended lug for bonding the rack/cabinet. The bonding jumper shall be connected to the AWG-2 conductor by means of an HTAP connector, protected with heat shrink material. When the project requires R56 grounding compliance, the bonding jumper shall be upsized to an AWG-2 and a vertical ground bar shall be provided for each rack/cabinet from top to bottom of each rack/cabinet. This ground bar shall be the termination point for the bonding jumper for each rack and shall also bond the manufacturer's approved grounding lug in the rack/cabinet to the ground bar.

T. RACK/CABINET BONDING OUTSIDE OF TELECOM ROOMS. Racks/cabinets outside of telecom rooms shall be bonded to the nearest electrical ground with a BC.

U. LABELING: All labeling systems for telecommunications grounding infrastructure shall be in compliance with the ANSI/TIA/EIA-606-C standard. At a minimum, the following elements shall be labeled in the telecommunications grounding system:
1. All TMGB or TGB, with a unique identifier located in the wall near the unit, not on the ground bar.
2. All TBBs in the project with a unique identifier at each termination point of each TBB. The label in one side of the cable shall indicate the termination location of the other side of the cable.
3. BC for rows of racks with a unique identifier at both ends of the cable
4. BC for surge protectors with a unique identifier at both ends of the cable

V. ADDITIONAL LABELING. All BCs boding rows of racks/cabinets and TBBs shall have additional to the identification marker a yellow printed wrap around tag installed close to the bonding point strap to the cable jacket with a flame retardant cable tie. This tag shall have the following wording in green letters: "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER".

3.2 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. See specification section 27 00 10 for as built and close out information requirements.

END OF SECTION 27 05 26

SECTION 27 05 28 - RACEWAYS FOR TECHNOLOGY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Section 26 05 33 - Raceway Systems, apply to work of this Section. Specifications described herein take precedence over Section 26 05 33.

C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 27 00 10 Technology General Provisions
   2. 27 05 26 Grounding and Bonding for Telecommunications Systems

1.2 DESCRIPTION

A. General: Furnish and install complete with all accessories a Pathways and Spaces infrastructure for supporting of Structured Cabling System (SCS) and housing of technology equipment. The goal of the project is to provide a reliable architecture of the building that shall serve as a support for transport of data, voice telephony, security and audio/visual cabling throughout the building from designated demarcation points to places located at various wall, floor, ceiling, column, room and other locations as indicated on the contract drawings and described herein.

B. General: For pathways the system shall utilize a combination of conduit, cable tray and supports for vertical and horizontal cabling support. Pathways shall be provided and located as shown and in the quantities indicated on the drawings. Pathways shall terminate in rooms or closets using approved fasteners and termination hardware and bushings and shall be reamed to eliminate sharp edges. All Pathways shall be identified at all locations.

C. All installers should anticipate that all products and installation procedures shall comply with the ANSI/TIA-569-E requirements at a minimum.

D. General: Installation of the raceways for communications shall be a complete system including all supports and hangers as required per contract documents and manufacturer’s installation guidelines.

E. Support: All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling

suspension wires or to ceiling channels. Do not install any devices supported by ceiling tiles.

F. Installation: The Installer shall layout and provide his work in advance of the laying of floors or walls, and shall provide all sleeves that may be required for openings through floors, walls, etc. Where plans call for conduit to be run exposed, provide all inserts and clamps for the supporting of conduit.

G. Pull Strings: Provide pull strings in all raceways. Pull strings shall be nylon and shall be impervious to moisture. Pull strings installed in one (1) inch and smaller conduits shall have a tensile strength of not less than 30 lbs. Pull strings installed in conduits larger than one (1) inch shall have a tensile strength not less than 200 lbs.

H. Directional boring might be required in the drawings or the installer might choose this method as the way to install underground conduit on this project. In either case, the installer shall comply with the requirements indicated here for directional boring.

I. If at the time of bid and underground locate survey is not available, the installer shall include in the pricing the cost of this survey. No directional boring will be allowed without such survey being completed.

1.3 INSTALLER QUALIFICATIONS

A. General: The installer selected for the Project must be BICSI certified installer and certified by the manufacturer for the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning the Project.

B. General: The Installer directly responsible for this work shall be a " Pathways and Spaces for Structured Cabling System Installer (PS-SCS) " who is, and who has been, regularly engaged in the providing and installation of commercial and industrial pathways and spaces for telecommunications wiring systems of this type and size for at least the immediate past five years. Any sub-Installer who will assist the PS-SCS installer in performance of this work, shall have the same training and certification as the PS-SCS installer.

C. Certification: The installer's Project Manager shall possess a current and in good standing BICSI Registered Communications Distribution Designer (RCDD) certificate. All shop drawings submitted by the installer shall bear the RCDD's seal.

D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and have personnel who are adequately trained in the use of such tools and equipment.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 27 00 10 are followed.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. See additional requirements for shop drawings and submittals in specification section 27 00 10.

B. General: The PS-SCS installer shall provide no later than 30 days after contract award the following information:
   1. Proof of Installer's qualifications per paragraph 1.03.
   2. Cut sheets of all products to be used for the project, highlighting in particular the precise product to be used in each case, when multiple devices are indicated in the cut sheet. At a minimum the following devices shall be submitted with this specification section:
      a. Supporting devices (j-hooks) if allowed in the project. See part 3 of this specification.
      b. Cable tray system with accessories
      c. Runway cable tray system with accessories.
      d. Plywood
      e. Trough wall/floor firestop system
      f. Innerduct
      g. Detectable tape
      h. Communications vaults
      i. Conduit waterfalls
      j. Fire stop system (for small penetrations)
   3. Drawings indicating precise location and type of all support for cable tray or ladder tray systems in all areas where they will be used.
   4. For all communication vaults, drawings shall be prepared indicating conduit penetrations on each side of each vault. Vaults shall be labeled to indicate their correct location in the site plan.
   5. Pre-cast communications vaults shall be submitted with load calculations signed and sealed by a professional engineer.
   6. For any directional boring runs, the installer shall provide a drawing indicating all underground locate surveys and the proposed routing of the conduit as well as proposed depth.

1.6 WORK EXTERNAL TO THE BUILDING

A. General: Any work external to the confines of this building as shown on the drawings shall be governed by provisions of this specification.

PART 2 - PRODUCTS

2.1 CONDUIT

A. All conduits as indicated in Section 26

2.2 TELECOMMUNICATIONS OUTLET BOX

A. Telecommunication outlet electrical boxes shall be used to make terminations to limited energy systems described in Division 27 and Division 28 specifications. Telecommunications outlet boxes shall have the following specifications:
   1. Material: Steel, 0.6858mm thickness (minimum) with galvanized zinc coating, 0.013mm (minimum) thickness on both sides of bracket
   2. Construction: Cleanly punched knockouts, welded at 8 points (minimum) with softened edges (no sharp edges).
   3. Size (HXW): 4”X4”
   4. Depth: 2-1/8”
   5. Knock outs: At least one of this dimension: 1”
   6. Listing: UL or ETL

B. Telecommunications outlet electrical boxes shall be provided with the appropriate 1 gang or 2 gang rings selected for the proper thickness of the drywall in all areas. Standard telecommunications outlets shall use 1 gang ring, but design documents might indicate the use of 2 gang rings in selected areas.

C. Knockouts in telecommunications outlet boxes shall not be field punched.

D. Basis of design: Raco, Steel City, Randal Industries Inc,

2.3 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. HDPE pipe shall be used for all directional boring applications, or it can also be used for open trench applications. HDPE pipe shall comply with the following manufacturing standards:
   1. ASTM D 3035 Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter.
   2. ASTM D 2239 Polyethylene (PE) Plastic Pipe (SIDR) Based on Controlled Inside Diameter.
   3. ASTM F 2160 Solid wall High Density Polyethylene (HDPE) Conduit based on Controlled Outside Diameter (O.D.)
   4. NEMA TC-7 Smooth Wall Coilable Polyethylene Electrical Plastic Conduit.

B. HDPE pipe shall be manufactured from a suitable thermoplastic polymer conforming to the minimum standard of PE334420E/C as defined in ASTM D3350. The resin properties shall meet or exceed the values listed below for HDPE pipe:

ASTM	Description	Values HDPE

Test		
D-1505	Density g/CM 3	0.941 - 0.955
D-1238	Melt Index, g/10 min Condition E	0.05 - 0.50
D- 638	Tensile strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B,F 20	96 min.
D-790	Flexural Modulus, MPa (PSI)	80,000 min.
D-746	Brittleness Temperature	-75°C

C. Design selection: The HDPE pipe used in this project shall be Rib/Smooth – Ribbed Interior and Smooth Exterior wall. Pipe shall be available in multiple colors, non lubricated and shall include a factory installed 1,800 lbs polyester pull tape. HDPE pipe walls shall be in compliance with SDR 7 - ASTM D3035 specifications and shall have footage markings.

D. Approved manufacturers: Carlon Industries or approved equal.

2.4 WIREWAYS

A. General: Wireway shall be sized as shown on drawings, NEMA 1, lay-in type. Wireway sides and bottom shall contain no knock-outs unless shown otherwise on the drawings. The Installer shall punch holes required. The cover shall be hinge type with quarter turn fasteners to hold cover shut. Covers and bodies shall be 16 gauge steel. Wireway shall be manufactured by Hoffman Engineering Company, Square "D" or Steel City.

2.5 SUPPORTING DEVICES

A. Hangers: Hangers shall be made of durable materials suitable for the application involved. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by galvanizing, or approved suitable preservative methods.

B. Non-continuous cable supports (j-hooks) shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed.

C. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

D. Non-continuous cable supports sized 1 5/16” and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

E. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.

F. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.

G. Anchoring: Insert anchors shall be installed on concrete or brick construction, with hex head machine screws. Recessed head screws shall be used in wood construction. An electric or hand drill shall be used for drilling holes for all inserts in concrete or similar

construction. Installed inserts, brick, shall be near center of brick, not near edge or in joint. Drilled and tapped, and round head machine screws shall be used where steel members occur. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust-resisting metal, or accepted substitution. Gunpowder or lead set anchors are not permitted.

H. Accessories: Non-continuous support systems shall be provided with the adequate mounting accessories depending on the location where the support will be installed, like beam clips, flange clips, C and Z purlin clips.

I. Accepted manufactures; Erico or Panduit.

2.6 CABLE TRAY AND FITTINGS (BASKET TYPE)

A. General Description: Basket type cable tray system is to be constructed of welded steel wire mesh with continuous safety edge wire lip. Provide mesh system permitting for continuous ventilation of cables and maximum heat dissipation.

B. Materials: Carbon Steel: Cable management system to be manufactured from high strength minimum 6 gauge steel wires. Wire to be welded and bent prior to surface treatment.

C. Finishes: Electro-plated zinc Galvanizing: Electrodeposited zinc coating applied to an average thickness of 0.7 mils to 0.8 mils.

D. Cable tray dimensions: as shown on the drawings.

E. Fittings: Cable tray fittings to be field manufactured from straight sections through use of hardware and instructions recommended by Manufacturer. Provide drop-off, 90° kits and tees as required using manufacturer fabricated products and installation guidelines.

F. Installation: Cable tray system to be installed using splice connectors, and support components as recommended by the Manufacturer.

G. Loading Cable tray system to be installed and supported per NEMA VE-2 and Manufacturer’s suggested span load criteria.

H. The cable tray system shall be UL listed and classified as a continuous bonded tray system providing a continuous grounding path. Cable tray system is required to be tested for grounding adequacy per NFPA 70B, Chapter 18 with a maximum allowable resistance of 1 ohm.

I. Approved Manufacturers: Wiremold, Cablofil, Snake Tray, B-line, WBT or Chatsworth.

2.7 CABLE TRAY AND FITTINGS (LADDER TRAY TYPE)

A. CABLE TRAY SECTIONS AND COMPONENTS

1. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
2. Materials and Finish: Material and finish specifications for each cable tray type are as follows:
    a. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
    b. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.
    c. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray. All hot-dip galvanized after fabrication steel cable trays must be returned to point of manufacture after coating for inspection and removal of all icicles and excess zinc. Failure to do so can cause damage to cables and/or injury to installers.
    d. Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.

B. TYPE OF TRAY SYSTEM
1. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced [6] inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200 pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.
2. Ventilated trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inches and shall be spaced 6 inches on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2-1/4 inch by 4 inch rectangular holes punched along the width of the bottom.
3. Solid bottom trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inch and shall be spaced 6 inches on center.
4. Tray Sizes shall have [3] inch minimum usable load depth, or as noted on the drawing.

5. Straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard [10] foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
6. Tray widths shall be as shown on drawings.
7. All fittings must have a minimum radius as the width of the tray.
8. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
    a. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1. If aluminum cable tray is to be used outdoors then hardware shall be Type 316 stainless.
    b. Steel (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Each splice plate shall be attached with four ribbed neck carriage bolts with serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.
9. Splice plates shall be furnished with straight sections and fittings.
10. Cable Tray Supports: Shall be placed so that the support spans do not exceed maximum span indicated on drawings. Supports shall be constructed from 12 gauge steel formed shape channel members 1-5/8 inch by 1-5/8 inch with necessary hardware such as Trapeze Support Kits. Cable trays installed adjacent to walls shall be supported on wall mounted brackets. All types of supports shall be factory made supports supplied by the same manufacturer of the cable tray system as recommended for the type of cable tray selected.
11. Trapeze hangers supports shall be supported by 3/8 inch (minimum) diameter rods.
12. Barrier Strips: Shall be placed as specified on drawings and be fastened into the tray with self-drilling screws.
13. Accessories - special accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.

C. LOADING CAPACITIES
1. Cable tray shall be capable of carrying a uniformly distributed load of 109 lbs /ft on a 12 foot support span with a safety factor of 1.5 when supported as a simple span and tested per NEMA VE1 Section 5.2. In addition to the uniformly distributed load the cable tray shall support a 200 lb. concentrated load at mid-point of span and centerline of tray. Load and safety factors specified are applicable to both side rails and rung capacities.

D. Approved Manufacturers: B-line, Chatsworth or approved equal.

2.8 TUBULAR RUNWAY CABLE TRAY AND FITTINGS

A. Materials: ASIM A36 steel bar.

B. Finish: Baked Powder painted surface treatment using Polyester coating.

C. Finish color: to match equipment cabinet finish color. See specification section 271000.

D. Cable management tray width: as shown on the drawings.

E. Fittings: Cable management fittings and hardware recommended by Manufacturer. Provide drop-off, 90° and tees as required for the equipment served and support of the cable. Provide at least one large radius drop off for each rack/cabinet in the project.

F. Installation: Cable management system to be installed using support components as recommended by the Manufacturer.

G. Loading: Cable management system to be installed and supported per Manufacturer's suggested span load criteria.

H. Approved Manufacturers: B-line, GS Metals, Chatsworth.

2.9 PLYWOOD BOARDS IN TELECOMMUNICATION ROOMS

A. Plywood Backboard: Backboards shall be installed in each TR and the MTR on walls to a height of 8' AFF or as shown on the drawings. Rooms shall have walls covered as shown on the drawings

B. Acceptable options for plywood boards are:
   1. ¾" AC Grade [fire rated] plywood painted with two coats of fire retardant paint in both sides and on the edges.
   2. Pre-manufactured plywood system for telecommunications such as ReadySpec by Pathways and Spaces Inc.

C. Other specifications:
   1. All imperfections and voids shall be filled, sealed and sanded prior to being primed and painted.
   2. Fire retardant coating shall be tested to UL723, "Test for surface burning characteristics of building materials."
   3. Paint color shall be grey, white or blue.
   4. Fire retardant plywood shall be clearly labeled with the name of the Backboard Manufacturer, UL Classification of the Fire Retardant Coating, NFPA 255 Coating Flame Spread Index Class and the APA Grade of the plywood.
   5. Plywood shall be installed with best side out.

2.10 THROUGH WALL/FLOOR FITTING FIRE STOP SYSTEM

A. General. These devices covered under this specification are firestop devices for use in through-penetration firestop systems, which are used to maintain the fire rating of the wall or floor, as well as to route and protect power and/or communications cable distribution for commercial, educational, healthcare, government, institutional, industrial and utility needs.

B. Classification and use: The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of 3.3 cfm. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4 1/2" (114mm) thick reinforced lightweight or normal weight (100-150 pcf) (1600-2400 kg/m3). The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.

C. Materials:
   1. Box: The fire stop device box shall be constructed of 16 gage G90 steel.
   2. Intumescent block: The fire stop device intumescent block shall be constructed of a graphite base material with expansion starting at 375º F and an unrestrained expansion between 6 to 12 times. The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.
   3. Adjustable doors: the fire stop device shall have doors or other system which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gage G90 steel with no. 10-32 screws use to adjust opening size.
   4. Heat shield: For retrofit applications where an existing in-wall conduit extends out from the wall more than 7/8" [22mm], a UL listed Heat Shield must be used in order to maintain UL Fire Classification. The firestop device is then installed onto the heat shield
   5. Split conduit and wall plate: For retrofit applications where no conduit is installed in the wall to protect existing cables, a split conduit assembly should be used to protect cables. After installing the split conduit within the wall, a wall plate should be installed to cover any irregularly shaped hole cut in the wall. The firestop device is then installed onto the conduit.

D. Sizes: the fire stop device shall be available for two (2) inch and four (4) inch trade size emt conduit.

E. Finish: the fire stop device shall be available in safety yellow or orange powder coat, custom colors and an unpainted galvanized finish.

F. Design selection: Wiremold FlameStopper, STI EZpath or approved equal

2.11 INNERDUCT (REGULAR)

A. Flexible raceway system also referenced in the design documents as regular innerduct or innerduct shall be provided in locations indicated in design drawings. The innerduct type

shall be selected according to the environment where it will be installed, use HDPE innerduct only outdoors, use plenum or riser rated innerduct indoors. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.

B. For plenum rated applications, the specifications of the innerduct shall be:
   1. Material: White or orange Kynar PVDF Resin, a fluoropolymer compound.
   2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
   3. Marking: Footage shall be sequentially marked.
   4. Configuration: corrugated type.
   5. Pull line: built in 900 lb rated tape.
   6. Size: Shall be available in ¾" through 2" diameters.

C. For riser rated applications, the specifications of the innerduct shall be:
   1. Material: Orange polyvinyl chloride (PVC).
   2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed in the product.
   3. Marking: Footage shall be sequentially marked.
   4. Configuration: corrugated type.
   5. Pull line: built in 900 lb rated tape.
   6. Size: Shall be available in ¾" through 2" diameters.

D. For outdoor applications, the specifications of the innerduct shall be:
   1. Material: High Density Polyethylene (HDPE).
   2. Listing: None.
   3. Marking: Footage shall be sequentially marked.
   4. Configuration: corrugated type.
   5. Pull line: built in 1,800 lb rated tape.
   6. Size: Shall be available in ¾" through 2" diameters.

E. All inner ducts shall be provided with couplings and accessories suitable for the environment where they will be installed.

F. Design selection: products by Carlon or approved equal.

2.12 INNERDUCT (FABRIC TYPE)

A. When indicated in the design drawings, high capacity innerduct made of fabric shall be used inside telecommunication raceways to facilitate the pulling of telecommunication wires in those raceways. The fabric type Innerduct (also referenced as textile innerduct) shall have the following specifications:
   1. Material: White Polyester and Nylon resin polymer
   2. Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape.
   3. Indoor Textile Innerduct (Riser-listed): Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.

4. Plenum-Listed Textile Innerduct: Micro (33mm), 2-inch and 3-inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.

B. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.

C. Design selection: Products manufacturer by The Maxcell Group or approved equal. Approved equal shall be only of the fabric type innerduct.

2.13 DETECTABLE TAPE

A. A detectable tape shall be installed above all underground conduit at a minimum depth of 18” or as shown on the drawings. The detectable warning tapes shall be constructed with a solid aluminum foil core with a minimum thickness of 5 mils and 3” wide. The detectable warning shall have printed diagonal warning stripes conform to APWA color recommendations and bold, black legends identify what type of utility line is buried below. All detectable tapes used for this shall be labeled “fiber optics buried below”.

B. Design selection: Detectable tape from Carlon, Stranco, Ind., Terra Tape or approved equal.

2.14 COMMUNICATIONS VAULT (POLYMER CONCRETE)

A. In ground communication boxes also referenced in this document as communications vaults (polymer concrete) shall have the following specifications:
1. Construction Material: Precast Polymer Concrete.
2. Listing: UL listed enclosure, tested to ANSI/SCTE 77
3. Box vertical design load: 22,500 lbs.
4. Box vertical test load: 33,750 lbs.
5. Box lateral design load: 800 lbs/sq. ft.
6. Box lateral test load: 1,200 lbs/sq. ft.
7. Box dimensions: as indicated in design drawings.
8. Box bottom: open bottom
9. Holes for conduit: holes for conduit shall be cut at the factory and shall not cover more than 25% of the side of the enclosure. All sides of the box shall have holes for conduits, even though conduits might not be shown for all sides in the floor plans. No less than two holes for standard 4” conduit shall be at all sides. All unused holes shall be plug with plastic caps.
10. Cover ANSI TIER: 22
11. Cover logo: “Communications”
12. Cover screws: two (2) tamper resistant penta head screws
13. Cover accessories: two (2) 7” long cover hooks made of electroplated steel.

B. Design selection: Hubell Quazite PG style box with HH series cover and accessories or approved equal. Approved equals shall comply with all specifications listed above including construction material.

2.15 COMMUNICATIONS VAULT (PRECAST CONCRETE)

A. In ground communication boxes also referenced in this document as communications vaults (precast concrete) shall have the following specifications:
   1. Construction Material: concrete 5000 psi @ 28 days
   2. Rebar: ASTM A 615 grade 60 rebar
   3. Mesh: Welded wire fabric ASTM A185 grade 65
   4. Size: As indicated in design drawings
   5. Design: comply with local building code for reinforced concrete
   6. Loads: Dead load: concrete 150 PCF
   1. Earth cover – 120 PCF
   2. Lateral Earth pressure on walls: Equivalent fluid pressure above water table + 36 PSF per foot of depth. Equivalent pressure below water table + 81.4 PSF per foot of depth.
   7. Live load: AASHTO HS20-44. 32,000 lbs. rear axle loading.

B. The cover and frame for the communications vault shall have the following specifications:
   1. Style: Hatch type [galvanized cover] [concrete lid] [concrete lid with ring and cover].
   2. Cover design (for hatch type or galvanized cover): Hot dip galvanized after fabrication built to an H20 rating for non roadway applications with dual doors.
   3. Cover design (for concrete lid with ring): 30” diameter cast or ductile iron, built to an H20 rating up to 150 KIO.
   4. Lettering: Covers shall be label as “Telecommunications”

C. All communications vault shall be provided with the following accessories:
   1. Embedded lifters made of galvanized steel
   2. All communications vaults with a concrete lid and ring shall be provided with a grade ring or riser made of concrete to bring the cover up to grade level. Precast concrete grade rings and cones shall comply with ASTM C 478, except that the wall thickness shall be 6 inches minimum. Provide interlocking keyways on rings and cones. Provide cones with cast in place inserts for the vault frame.
   3. Embedded pulling irons made or carbon steel galvanized.
   4. Two lengths of embedded unistrut (galvanized) for bolting equipment on 2 opposite walls of the vault.

D. Precast vault construction shall be in the form of monolithic walls or horizontal wall sections. Do not use panel walls.

E. Minimum wall thickness shall be 6 inches. Design knockout wall panels to accommodate loading pressures defined above.

F. Design and construct vaults to be watertight when subjected to groundwater over the entire height of the vault.

G. Provide openings in precast vaults for piping and access. Provide cast in place inserts in the roof slab and end walls at the locations as shown on the Drawings. No field coring of openings is allowed.

H. When communications vault are made of different sections, they shall be sealed and bonded with a double layer of plastic sealing compound and make watertight. Plastic sealing compound shall comply with Federal Specification SS-S-00210. Fill with mortar all recesses, lifting inserts, or other cavities not filled with plastic sealing compound. Mortar shall comply with ASTM C 387, Type S.

2.16 CONDUIT WATERFALLS

A. All 4" EMT terminations with communication cable entering/exiting the conduit from a cable tray (or tubular runway) system and the vertical separation between raceways is larger than 7” shall be fitted with a device to control the bend radius of the communication cable to a minimum of a 4" radius. The device to control the bend radius shall be called a conduit waterfall and must comply with all National Electrical Code requirements and TIA/EIA Standards. In addition, the product must be RoHS compliant to meet environmental requirements, be UL 94V-0 approved to reduce the spread of flame, and be approved by UL for use in air handling spaces. The device to provide bend radius control must support a static load of 40 lbs. (177.9 N) and have a fastening device that allows for incremental adjustments to conform to variances in conduit diameters.

B. Device quantities are not indicated in the drawings but the PS-SCS shall use all 4” conduits and sleeves indicated in the drawings to estimate the quantities of waterfalls to be used in the project.

C. Basis of design: Panduit CWF 400 or approved equal.

2.17 FIRE STOP SYSTEMS (FOR SMALL PENETRATIONS)

A. General: Fire stop system shall be selected by the PS-SCS installer as to comply with the following requirements:
   1. Selected system shall be UL listed for the condition on which it will be installed. These conditions include: wall/slab type (masonry, drywall, etc), hour rating, and accessibility type.

B. Acceptable systems: caulk based products or firestop grommets by STI or equal.

2.18 EXPANSION FITTINGS

A. Installation: Provide expansion fittings in each conduit run wherever it crosses an expansion joint. Install the fitting on one side of the joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.

B. Location: Provide expansion fittings in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.

C. Length: Provide expansion fittings in straight conduit runs above ground which are more than one hundred (100) feet long.

D. Flex conduit is not allowed to be used as expansion fittings.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. See additional requirements indicated in part 3 of specification section 27 00 10.

3.2 INDOOR CONDUITS BELOW GRADE AND ABOVE GRADE

A. BEND RADIUS. Conduits shall utilize long radius sweeps at all 90 degree transitions. The inside radius of a bend in conduit shall be at least six (6) times the internal diameter. When the conduit size is greater than two (2) inches, the inside radius shall be at least ten (10) times the internal diameter of the conduit. For fiber optic cable, the inside radius of a bend shall always be at least ten (10) times the internal diameter of the conduit

B. ENCLOSURES USED AS CONDUIT BENDS. Enclosures such as junction boxes, handholes or communications vaults shall not be used to change direction of conduits, unless the enclosures are large enough to preserve the bend radius of the conduit as indicated in the point above. As an example, a junction box with 4” conduits entering in two adjacent sides of the enclosure should preserve a minimum of 40” radius between the closest conduits in the adjacent sides of the enclosure. It is required, that if the enclosure sizes don’t meet this criteria, the conduit bends shall be done before entering the enclosure.

C. ENCLOSURES FOR STRAIGHT PULLS. Enclosures such as junction boxes, handholes or communications vaults used in straight pulls, shall have a minimum length to allow for proper cable pulling. Enclosures with terminating conduits from 2” to 3” in size shall use enclosures with a minimum length of 24”. Enclosures with terminating conduits of 4” in size shall use enclosures with a minimum length of 36”. It is acceptable to use metallic wireways as junction boxes for straight pulls as long as they are installed with the cover accessible to the end user.

D. MAXIMUM DISTANCE BETWEEN JBOXES. For indoor installation no section of conduit shall be longer than one hundred (100) ft or contain more than two (2) 90 degree bends between pull points or pull boxes are required. For outdoor installation no section of conduit shall be longer than six hundred (600) ft. or contain more than two 90 degree bends between pull points or pull boxes are required.

E. LABELING. All indoor conduits 2” or larger shall be labeled at both ends when these conduit runs are continuous between two rooms and going through multiple walls or slabs. Labeling materials shall be as indicated in specification section 270010. Conduit sleeves 2” or larger penetrating just one wall is not required to be labeled.

F. PULL STRINGS; All conduits for technology systems shall be installed with pull strings.

3.3 UNDERGROUND TELECOMMUNICATIONS DUCT LINES

A. Description: Underground duct lines shall be of individual conduits. Conduits shall be encased in concrete where indicated on the plan drawings and duct bank sections. The conduit shall be of plastic, PVC Schedule 40, unless indicated or specified otherwise. The conduit used shall not be smaller than four (4) inches in diameter, inside, unless otherwise noted on the drawings.

B. The concrete encasement surrounding the duct bank shall be reinforced as shown and rectangular in cross-section, having a minimum concrete thickness of two (2) inches. Conduit shall be separated by a minimum concrete thickness of two (2) inches. The concrete work shall conform to Section on "Concrete". The top of the concrete envelope shall be not less than eighteen (18) inches below grade. Concrete shall be installed in a continuous pour to eliminate joints in the duct run.

C. Duct lines shall have a continuous slope downward toward communication vaults and away from buildings with a pitch of not less than 0.125 inches per foot. Changes in direction of runs exceeding a total of ten (10) degrees either vertical or horizontal shall be accomplished by long sweep bends having a minimum radius of curvature of twenty five (25) feet, except that manufactured bends may be made up on one or more curved or straightened sections or combinations thereof. Manufactured bends shall have a minimum radius of forty eight (48) inches.

D. Conduits. Conduits shall terminate in end-bells where duct lines enter manholes or communications vaults. Provide four (4) to six (6) inch reducers as required. Separators shall be of pre-cast concrete, high impact polystyrene, steel or any combination of these. The joints of the conduits shall be staggered by rows so as to provide a duct line having the maximum strength. During construction partially complete duct lines shall be protected from the entrance of debris, such as mud, sand and dirt by means of suitable conduit plugs. As the duct line is completed, a testing mandrel not less than 13 inches long with a diameter 1/4 inch less than the size of the stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand or gravel; conduit plug shall then be immediately installed.

E. Conduit. Plastic conduit, fittings and joints shall not have been stored in the sun or weather, in any excessively heated space, or unevenly supported during storage. Use and installation shall be in accordance with the National Electrical Code requirements for the installation of non-metallic rigid conduit. Plastic conduit shall be protected against the direct rays of the sun prior to installation. Conduit shall be Carlon Type EB, Queen City Plastics, or accepted substitution. Conduit shall be U.L. listed and conform to NEMA Standard TC6 1972.

F. Trench: Trenches for duct banks shall be completely dry before setting conduits or pouring concrete. Well pointing as required shall be provided if necessary to keep trench dry.

G. Excavation: Backfilling shall be in layers not more than eight (8) inches deep, and shall be thoroughly tamped. The first layer shall be earth or sand, free from particles that would be retained on a 1/4 inch sieve. The succeeding layers shall be excavated material having stones no larger than would pass through a four (4) inch ring. The backfill shall be level with adjacent surface, except that in sodded or paved areas, a space equal to the thickness of the sod or paving shall be left.

H. Finish: The surface disturbed during the installation of duct shall be restored to its original elevation and condition if not refinished in connection with site work.

I. Plugging: All unused conduit openings shall be plugged or capped with a suitable device designed for the purpose; caulking compound shall not be used for plugging conduit openings.

J. Stubs: Spare conduit stubs shall be capped and marked in the field and accurately dimensioned on the as-built drawings.

K. Spacers: All conduit run underground, or stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel.

L. Minimum burial depth: All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300 5 of the NEC except that the minimum cover for any conduit or duct bank shall be two (2) feet, unless otherwise indicated.

M. Directional boring. For all applications requiring directional boring the following installation practices shall be followed.
1. The installer shall select the directional boring equipment based on the length of the pulls, soil conditions, pipe size, and pipe quantities.
2. When multiple pipes are run, each pipe shall be a different color.
3. Any pipe run less than 1,500 ft, shall be run as a single pull without splices.
4. Any splices done to HDPE pipes shall be done with manufacturer’s approved methods.

3.4 INSTALLATION OF COMMUNICATIONS VAULTS

A. Excavating and backfilling for vaults. Perform earthwork as specified in Division 2. Provide 6-inch minimum thickness 3/4-inch crushed rock over the full width of the vault base and extend 12 inches beyond the edges of the vault. After repairing the waterproofing, backfill and compact around the vault with structural backfill material. Excavated material may be used for structural backfill provided it conforms to the Standard Specifications for structural backfill material.

B. Installing vaults and risers. Set each concrete vault section or riser plumb on a double layer bed of sealant at least 1/2-inch thick to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.

C. Waterproofing. Waterproofing shall be factory applied to all exterior surfaces of vaults and risers. This includes the bottom of the vault to be coated as an exterior surface. Apply two coats at a rate of 65 square feet per gallon per coat. Prior to backfilling, field apply waterproofing material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting.

3.5 CUTTING AND PATCHING

A. Core Drilling: The installer shall be responsible for all core drilling as required for work under this section, but in no case shall the installer cut into or weld onto any structural element of the project without the written approval of the A&E. Any post tension slabs or slabs with embedded electrical raceways shall be X-rayed prior to coring by the installer.

B. Cutting and Patching: All cutting, rough patching and finish patching shall be provided as specified in the contract documents. All cutting and patching shall be performed in a neat and workmanlike manner.

C. Openings and Sleeves: Locate all openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.

D. Roof Penetration: All roof penetrations for raceways part of technology systems shall be approved by A&E prior to executing this work. All roof penetrations shall be as accepted by the roof manufacturer.

3.6 IDENTIFICATION OF BOXES

A. Tags: During installation of pull strings all pull strings shall be marked with waterproof vinyl tags indicating where the opposite end may be found.

3.7 BLANK PLATES

A. Plates: Unless otherwise noted all unused outlet boxes shall receive blank plates matching the finish of plates for electrical devices in the same room.

3.8 RACEWAY INSTALLATION

A. SUPPORT. All raceways shall be run in a neat and workmanlike manner and shall be properly supported and in accordance with the latest edition of the NEC code and BICSI guidelines. Supporting conduit and boxes with wire is not acceptable. Exposed raceways where allowed, shall be supported with clamp fasteners with toggle bolt on hollow walls, and with no lead expansion shields on masonry. All conduits shall be securely fastened in

place with at least one support per eight foot section. Support within one foot of changes in direction. All required hangers, supports and fastenings shall be provided at each elbow and at no more than one foot from the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits shall not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

B. HANGER INSTALLATION. Where two (2) or more conduits one (1) inch or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These conduits shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.

C. NON-CONTINUOUS CABLE SUPPORTS INSTALLATION. When j-hooks are allowed in the project by this specification (See USE OF CONDUIT FOR DIFFERENT SYSTEMS) non-continuous cable supports (j-hooks) shall be installed only as recommended by manufacturer not exceeding the load ratings of the devices. Install non-continuous cable supports in spans no longer than 4’. Whenever there are changes in elevation additional supports shall be required to avoid having stress on cable or sharp bends.

D. PENETRATIONS IN FIRE RATED PARTITIONS. Installation of electrical boxes or equipment backboxes in fire rated walls and smoke barriers shall follow the following requirements:
   1. Electrical boxes and or technology system backboxes can be installed in 1 or 2 hour rated walls as long as all requirements indicated in the proper Building Code, National Electrical Code and nationally recognized testing laboratories are met for this type of installation.
   2. As a summary, some of the requirements indicated by the codes listed above are:
      a. Boxes shall be metallic or listed for that purpose
      b. The area of the boxes shall not exceed 16 square inches, provided the aggregate are of the openings through the membrane does not exceed 100 square inches in any 100 square feet of wall area.
      c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch.
      d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used.
   3. Electrical boxes or technology systems backboxes shall not be installed in a 3 or 4 hour fire rated walls.

E. ROUTING: Conduits shall be run parallel to building walls wherever possible, exposed or concealed as specified, and shall be grouped in workmanlike fashion. Crisscrossing of conduits shall be minimized.

F. PROTECTION DURING CONSTRUCTION. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction until wires are pulled in and covers are in place. No conductors shall be pulled into raceways until the raceway system is clean and complete.

G. PROTECTIVE BUSHINGS: All un-terminated conduits shall have an insulated protective bushing to avoid cable damage at the edge of the conduit.

H. AVOIDING EMI: To avoid EMI for Telecommunications cabling and/or conduit containing cabling, all raceways shall provide clearances of at least four (4) feet (1.2 meters) from motors or transformers; one (1) foot (0.3 meter) from conduit and cables used for electrical-power distribution; and five (5) inches (12 centimeters) from fluorescent lighting. Raceways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The Installer shall not place any raceway alongside power lines

I. COORDINATION. All raceways shall be kept clear of mechanical equipment and plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.

J. MASONARY INSTALLATION. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.

K. USE OF CONDUIT IN DIFFERENT AREAS. When low voltage cables (any technology system) have to be run above ground in a space with no type of accessible ceiling (interior or exterior), all cable runs shall be in conduit completely, continuing the raceways all the way to the nearest accessible ceiling (in the direction of the telecom closet) or grouping the raceways into a single larger diameter conduit with the same or larger cross sectional area than the sum of all the conduits coming into it. The use of j-hooks to support low voltage cables in areas with no ceiling or inaccessible ceiling (e.g. hard ceilings) shall not be allowed. This type of condition is usually not indicated in the drawings because design drawings don't show conduits smaller than 2", nevertheless it shall be provided as indicated herein.

L. USE OF CONDUIT FOR DIFFERENT SYSTEMS: The following paragraphs indicate the design intent for raceways system for all technology systems.
   1. For all systems under division 27: Conduit stub up from the outlet to the nearest cable tray or telecommunications room.
   2. For all systems under Division 28 with the exception of Fire Alarm and Security Voice Communication system: Conduit stub up from the outlet to the nearest cable tray or telecommunications room.
   3. Non-continuous support systems (J-hooks) are allowed in this project as a horizontal support system for cables above ceilings. J-hooks shall not replace the cable tray system shown in the drawings.

3.9 CABLE TRAY INSTALLATION

A. Inspection: Examine area for clearances, to allow proper installation of the tray according to the routing indicated on the drawings. Check existing building steel and other

supporting structures to establish the type of tray hangers to be used and at the proper spans.

B. Installation Criteria: Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines

C. Support: Cable tray support shall be by means of welded angle brackets to structural components, brackets shall be as manufactured by the Cable tray manufacturer. Complete straight section of cable tray shall have at least 1 support at a ¼ of the length of the section. Additional supports are required at tray ends, offsets, bends and changes of elevation.

D. Grounding: All conduits terminating within 12 inches of a cable tray shall be bonded with a grounded in accordance with the National Electric Code.

E. Coordination: Wherever possible, install horizontal cable trays above water and steam piping. Coordinate installation of tray with other trades for clearances, to avoid conflicts. A minimum of 300 mm (12 in) access headroom shall be provided and maintained above the cable tray system or cable runway. A minimum of 150 mm (6 in) access headroom shall be provided and maintained at both sides (one side if tray is supported at the wall. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, structural elements) do not restrict access. The cable tray must be installed with at least 75mm (3 in) of clear vertical space above the ceiling tiles and support channels (T-bars) to ensure accessibility. When crossing other building components with the cable tray or runway the above specified clearances shall be maintained.

3.10 RUNWAY CABLE TRAY OR CABLE TRAY SYSTEM INSTALLATION INSIDE T.R.

A. GENERAL. Runway cable tray systems or cable tray systems being installed inside telecom rooms shall be installed following manufacturer’s recommendations for installation and all the following requirements indicated in this specification section.

B. SUPPORT LOCATIONS. Supports shall be provided as recommended by the manufacturer, but as a minimum supports shall be located as follows:
1. Before each 90 deg turn.
2. No continuous section shall have more than 3ft of span without a support.
3. At each 2-post rack or 4-post rack
4. At each change in elevation

C. SUPPORT TYPE. When the runway/cable tray is to be installed against the wall, the only support type to be used is a wall bracket supporting from the bottom of the tray. For sections of runway/cable tray to be installed over racks, the preferred support system is to the racks themselves. Trapeze style support brackets shall only be used when no other method of support is possible. Center hung support systems shall never be used.

D. VERTICAL SECTIONS. Runway/cable tray system shall be installed continuously vertically in all telecommunications rooms in the project from sleeves coming from the

ground (or floor below) to the sleeves going to the floor above, whether or not indicated in the drawings. The runway/cable tray installed shall have the same width as the total width of the sleeves coming into the telecommunications room, although multiple sections installed together are acceptable. If the sleeves from the floor below to the floor above don't line up in a straight line, two vertical sections are accepted, one to the horizontal runway cable tray and one from the horizontal runway cable tray to the sleeves above. Runway/cable trays installed vertically shall have supports to the floor, wall and slab above.

E. VERTICAL SECTIONS TO CONDUITS. Runway/cable tray shall be installed continuously vertically in all telecom rooms in the project when conduits larger than 2" terminate in the telecom room at the height higher than 4' from the highest vertical runway/cable tray installed above the racks. The runway/cable tray installed shall have the same width as the total width of the sleeves coming into the telecommunications room, although multiple sections installed together are acceptable. The length of these sections of runway shall be the complete length from the vertical runway/cable tray to the conduits stubbing in the room. The idea for these runway/cable tray sections is to provide support for the cables coming out of the conduit to the vertical runways/cable trays. Runways/cable tray installed vertically shall a standoff of no less than 1" from the wall to allow for proper lacing of the cables.

F. CABLE DROP OUT. At each rack or cabinet that has runway/cable tray system running on top of it, a cable dropout shall be installed to protect the bend radii of the cable. This dropout accessory shall have a bend radius of no less than 4".

G. BONDING. Any two continuous sections of runway/cable tray system shall be bonded together with a #1 bonding jumper (600A) 15" long. All bonding jumpers shall be made of steel with yellow, zinc-dichromate finish. All fasteners shall be made of steel with zinc-plated finish. See specification section 27 05 26 for more details.

H. PROTECTIVE END CAPS. All end sections of runway cable tray sections shall be protected with plastic protective end caps.

3.11 INSTALLATION OF INNERDUCT

A. PROTECTION. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during construction.

B. SUPPORT. When inner duct is laid on a cable tray, it shall be strapped to cable tray with nylon ty-wraps at periodic intervals of no less than 4 ft.

C. COLOR CODING. When multiple inner duct are in a single conduit, and innerduct are of the same size, they shall be different colors for identification or have different color electrical taped wrapped on the ends to identify them at the end of each conduit.

D. USE OF INNERDUCT. Any continuous conduit installed below grade or above grade with a size of 3 inches or larger shall have innerducts inside, along the complete conduit run. In particular for 4" conduits, a minimum of three (3) innerducts shall be installed inside each

conduit, regardless if cables are being run as part of this project or not. One of those innerducts shall be a 1-1/2", the other two innerducts shall be 1" innerducts.

3.12 USE OF FIRE STOP SYSTEMS

A. CABLE TRAYS. Cable trays or tubular runways shall not be allowed to pass continuously through a fire rated partition or smoke barrier. The following guidelines shall be followed to seal those openings:
   1. Use only UL listed methods per the wall rating.
   2. Pillow type or brick type systems are not allowed.
   3. For cable trays 12" in width or less, use only 4" through wall fitting fire stop systems. The quantity of systems shall be dependent on the cross sectional area of the cable tray system installed. The total cross sectional area of the fittings installed shall match the cross sectional area of the cable tray system installed. As an example, a 12" wide cable tray, 4" high shall have four (4) through wall fitting fire stop systems regardless of how many cables are being run on the cable tray system.
   4. For cable trays wider than 12", use a combination of 4" EMT sleeves with fire caulk based systems and through wall fittings fire stop system. The total cross sectional area of the sleeves/fittings installed shall match the cross sectional area of the cable tray system. To determine the quantity of sleeves and fittings for each case, the following method shall be used. All cables installed as part of this contract can be run through 4" sleeves with fire caulking and remaining sleeves, but no less than 1/2 of all sleeves required shall be through wall fitting fire stop systems. So, as an example an 18" wide, 4" high cable tray, requires a total of 6 4" sleeves. Out of those six, there shall be no less than three 4" through wall fitting fire stop systems with no cables installed inside and no more than three 4" sleeves with fire caulking with all cables installed as part of this contract, regardless of how many cables are being run on the cable tray.

B. SMALL CONDUIT SLEEVES. When J-hooks are allowed in the project and small cable bundles are required to go through a rated partition, it is acceptable to use fire caulk. A small bundle of cables is defined as a bundle than can fit on a sleeve that is 1.5" in size or less. For larger bundles, requiring 2" sleeves or larger, use only through wall fitting fire stop systems.

C. CONTINUOUS CONDUITS RUNS. Continuous horizontal conduit runs or conduit entering a rated telecom room shall be fire stop with caulk based fire stop systems, regardless of the size of the conduit.

D. ELECTRICAL BOXES. Installation of electrical boxes or equipment backboxes in fire rated walls and smoke barriers shall follow the following requirements:
   1. Electrical boxes and or technology system backboxes can be installed in 1 or 2 hour rated walls as long as all requirements indicated in the proper Building Code, National Electrical Code and nationally recognized testing laboratories are met for this type of installation.
   2. As a summary, some of the requirements indicated by the codes listed above are:
      a. Boxes shall be metallic or listed for that purpose

b. The area of the boxes shall not exceed 16 square inches, provided the aggregate are of the openings through the membrane does not exceed 100 square inches in any 100 square feet of wall area.
c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch.
d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used.

3. Electrical boxes or technology systems backboxes shall not be installed in a 3 or 4 hour fire rated walls.

E. VERTICAL SLEEVES. Fire stop system shall be used for all 4” vertical sleeves used inside telecom rooms to run from one floor to the next. Half the sleeves indicated in the design drawings shall be protected with caulk based fire stop systems and the other half with through floor fittings fire stop systems.

3.13 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. See specification section 27 00 10 for as built documents and close out information these requirements.

END OF SECTION 27 05 28

SECTION 27 10 00 - STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. General: Telecommunications Drawings apply to work of this section. The overall and detailed Structured Cabling System (SCS) design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.

B. General: Furnish, install, test and certify complete with all accessories an ANSI/TIA 568D SCS with a minimum 25 year performance warranty for the entire system from the manufacturers and a minimum of 3 years warranty for materials and labor from the SCS installer for all components not covered under the manufacturer's 25 year warranty. The goal of the project is to provide an enhanced SCS that shall serve as a vehicle for the transport of voice telephony, data, audio, video, security and low voltage devices for building controls and management, throughout the building and from building to building from designated demarcation points to outlets located at various desk, workstation and other locations as indicated in the contract drawings.

C. Coordination with other trades: It is the responsibility of the installer of the SCS to verify and advise the installer of the raceway infrastructure (conduit, boxes, cable tray, in ground boxes, etc.) for this system on raceway routing to minimize the wiring distances to the telecommunication room. When J-hooks are acceptable for the use in structured cabling system, all J-hooks and supports for these devices shall be in the scope of work of the SCS installer.

D. All patching and cross connect to owner provided equipment shall be included under the scope of work of this project.

1.2 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section

B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section:

Section	Title
27 00 10	TECHNOLOGY GENERAL PROVISIONS
27 05 28	RACEWAYS FOR TECHNOLOGY
27 05 26	GROUNDING & BONDING FOR TELECOMMUNICATIONS SYSTEMS

C. Owner standards: Comply with the document “Requirements for all Communication Cabling at Clients name” prepared by the Clients applicable office.

D. Standards: All work related to the SCS shall be in compliance with the following industry codes and standards latest edition:
   1. ANSI/TIA-568.0-D “Generic Telecommunications Cabling for Customer Premises” with addendums and errata.
   2. ANSI/TIA-568.1-D, “Commercial Building Telecommunications Cabling Standard” with addendums and errata.
   3. ANSI/TIA-568.2 - D, “Balanced Twisted- Pair Cabling Components Standard” with addendums and errata.
   4. ANSI/TIA-568.3-D, “Optical Fiber Cabling Component Standard” with addendums and errata.
   5. ANSI/TIA-569-D, “Telecommunications Pathways and Spaces” with addendums and errata.
   6. ANSI/TIA-606-C, “Administration Standard for Telecommunications Infrastructure” with addendum and errata.
   7. ANSI/TIA-607-D, “Generic Telecommunications Bonding and Grounding (earthing) for Customer Premises” with addendum and errata.
   8. ANSI/NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
   9. ANSI/TIA 758-B, “ Customer-Owned Outside Plant Telecommunications Infrastructure Standard” with addendum and errata
   10. ANSI/TIA 862-B, “Structured Cabling Infrastructure Standard for Intelligent Building Systems” with addendum and errata.
   11. ANSI/TIA-1152-A, “Requirements for Field Test Instruments and Measurement for Balanced Twisted Pair Cabling” with addendum and errata.
   12. ANSI/TIA-526-7-A, “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant”.
   13. ANSI/TIA-526-14-C, “Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant”.
   14. TIA-598-D, Optical Fiber Cable color coding.
   15. IEC/TR3 61000-5-2 - Ed. 1.0 and amendments. “Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling”
   16. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
   17. ANSI/NFPA 70 “National Electrical Code”, CSA C22.1.
   18. BICSI Telecommunications Distribution Methods Manual (TDMM)
   19. BICSI Telecommunications Cabling Installation Manual (TCIM)
   20. BICSI Customer Owned Outside Plant Manual (COOPM)
   21. Local County/City Codes, Ordinances and Regulations.
   22. Underwriters Laboratories (UL)
   23. FCC -Federal Communications Commission
   24. ADA Requirements
   25. Occupational Safety and Health Regulations (OSHA)
   26. National Fire Protection Association (NFPA)
   27. ANSI/TIA-1179, Healthcare Facility Telecommunications Infrastructure Standards
   28. Idaho Statutes and Administrative Rules
   29. Manufacturers Product Cabling Catalogs
   30. Manufacturers Training Manuals (Design and Installation).

E. General: Installation practices for SCS as describe herein take precedence over any other section in the construction documents set.

1.3 STRUCTURED CABLING SYSTEM INSTALLER QUALIFICATIONS

A. General: The installer selected for the project must be certified by the manufacturers of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturers components and distribution channels in provisioning the Project.

B. General: The installer directly responsible for this work shall be a Structured Cabling System (SCS) Installer who is, and who has been, regularly engaged in the providing and installation of commercial and industrial telecommunications wiring systems of this type and size for at least the immediate past five years. Any other company working for the SCS installer of this system shall have the same training and certification as the SCS installer.

C. Certification: The SCS installer's Project Manager shall possess a current and in Good Standings BICSI Registered Communications Distribution Designer (RCDD®) certificate. All shop drawings submitted by the SCS Installer shall bear the RCDD's stamp.

D. The SCS Installer shall have a (BICSI) RCDD on Staff. Third party RCDD's shall not be acceptable.

E. The Installer team leader assigned for the project shall be BICSI registered Level II installer or proven and qualified equal.

F. Experience: The SCS Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The SCS Installer shall own and maintain tools and equipment necessary for successful installation and testing of SCS and have personnel who are adequately trained in the use of such tools and equipment. The Owner or engineer may elect to request submittal of additional financial, operational and administrative information of the SCS installer to demonstrate the required experience.

G. The SCS Installer shall possess a State of Idaho Low Voltage License.

H. The SCS Installer shall maintain a permanent office within 150 miles of the project site.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. SCS Installer shall follow all requirements for materials alternates and substitutions indicated in specification section 27 00 10.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. See additional requirements for shop drawings and submittals in specification section 27 00 10.

B. Proposal Submittals: The SCS Installer shall submit the following information with the proposal to execute the work:
   1. A list of five (5) recently completed projects of similar type and size with contact names and telephone numbers for each.
   2. A list of test equipment proposed for use in verifying the integrity of the installed SCS. Test equipment list shall include manufacturer part number, serial numbers and a copy of the last calibration report done by the manufacturer of the equipment of the unit, indicating the date when the calibration was done. Calibrations shall not be older than one year. Test equipment includes, cable certifiers, OTDRs, fiber splicers, etc.
   3. A technical resume of experience for the installer's engineer/RCDD and on-site foreman who will be assigned to the project, including RCDD license number.
   4. Similar documentation for any company working for the SCS Installers who will assist in the performance of this work.
   5. A copy of a current and valid Low voltage License for the State of Idaho.
   6. Location of office from which installation and warranty work will be performed.

C. Construction submittals: Once all proposal submittals have been received and approved by the Architect and Engineer (A&E) of the project, the SCS Installer shall provide all construction submittals. Construction submittals are composed of the following items.
   1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the cut sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
   2. Faceplate color selection.
   3. Detail explanation of the labeling scheme to be used for all components of the system. This explanation shall include examples of all types of labels to be used, like labels for cables, patch panels, outlet jacks, etc.
   4. Autocad® or Revit drawings in sheets matching the size of the design documents with the following information:
      a. Floor plans with all outlets in the project. All outlets shall have the label to be used during identification and tagging process described in this specification section.
      b. Enlarged telecommunication rooms with all equipment components and rack layouts for each room. All racks shall have the label to be used during identification and tagging process described in this specification section.
      c. Drawings indicating rack elevations for all cabinets or racks in the project, identifying the precise quantity of patch panels, fiber distribution centers and wire managers and accurate RU heights based on equipment selection. All equipment shall have the label to be used during the identification and tagging process described in this specification section.
      d. A spreadsheet indicating all patch cords (fiber and copper) to be provided in the project. The spreadsheet shall indicate the quantity, color of the jacket, cable type, length, and connector termination on each side.

D. Construction submittals received before proposal submittals are received or approved will be rejected.

1.6 ABBREVIATIONS

A. General: The following abbreviations are used in this specification section:
1. A&E - Architect and Engineer. The Architect is the legal entity that holds a contract for the design the project. The Engineer is the consulting engineer firm or engineer of record for the project who prepared this specification.
2. APC - Angle physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
3. Array connector - a multi-strand fiber connector user for high density applications, such as the MPO connector
4. BICSI - Building Industry Consultant Services International
5. CCTV - Close circuit television system (surveillance video system)
6. FCC - Federal Communications Commission.
7. FTP - Foiled Twisted pair. One foiled screen around each cable pair.
8. IDC - Insulation Displacement Connector
9. NEC - National Electrical Code.®
10. NEMA - National Electrical Manufacturers Association.
11. OM1 - ISO 11801 designation for multimode 62.5/125µm glass fiber optics.
12. OM2 - ISO 11801 designation for multimode 50/125µm glass fiber optics.
13. OM3 - ISO 11801 designation for multimode laser optimized 50/125µm glass fiber optics.
14. OM4 - TIA designation for multimode laser optimized 50/125µm glass fiber optics in compliance with TIA-492-AAAD.
15. OS1 - ISO 11801 designation for single mode 9/125µm glass fiber optics.
16. OS2 - ISO 11801 designation for single mode 9/125µm glass fiber optic with performance criteria identical to ITU-T G652.
17. OTDR - Optical Time Domain Reflectometer.
18. RU - Rack units. Height dimension for rack mounted equipment. 1 RU equivalent to 1.75”.
19. SCS - Structured Cabling System
20. ScTP - Screened twisted pair. One foiled screen around all cable pairs
21. TIA - Telecommunications Industry Association.
22. TR - Telecommunications Room.
23. UPC - Ultra physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
24. UTP - Unshielded twisted Pair
25. UV - Ultra violet
26. VAC - Volts alternating current.

PART 2 - PRODUCTS

2.1 MODULAR SCS JACKS

A. Structured cabling system outlets indicated in design drawings are composed of modular SCS jacks, mounted in a faceplate on an electrical box. Modular SCS jacks shall be 8-pin modules (RJ-45) that meet or exceed the following electrical and mechanical specifications:
   1. Electrical Specifications:
      a. Insulation resistance: 500 MΩ minimum.
      b. Dielectric withstand voltage 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
      c. Contact resistance: 20 M Ω maximum.
      d. Current rating: 1.5 A at 68 º F (20 º C) per IEC publication 512-3, Test 5b
      e. ISO 9001 Certified Manufacturer
      f. UL verified for EIA/TIA electrical performance
      g. Comply with FCC Part 68
      h. Cable termination: IDC type universal T568A or T568B.
   2. Mechanical Performance:
      a. Plug Insertion Life: 750 insertions
      b. Contact Force: 3.5 oz (99.2 g) minimum using FCC-Approved modular plug.
      c. Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack.
      d. Temperature Range: -40º to 150ºF (-40 º to 66 º C)

B. Design selection: modular SCS jacks shall be selected according to the following criteria:
   1. Performance requirement: CAT6A
   2. Style: Rear loading
   3. Mounting orientation: straight mounting
   4. Color: To match faceplate
   5. Dust cover required: No
   6. Shielding: use shielded modular jacks only with ScTP cable.

C. Approved manufacturer: Tripp Lite.
   1. Cat 6 Yellow – N238-001-YW
   2. Cat 6 White – N238-025-WH
   3. Cat 6 Black – N238-001-BK
   4. Cat 6 Green – N238-001-GN

2.2 FIELD TERMINATABLE 8 POSITION MODULAR PLUG

A. When indicated in the design drawings to use Direct Attach connection for any field devices, field terminable 8 positions modular plugs shall be used. This devices shall be 8-pin modules (RJ-45) plugs that meet or exceed the following electrical and mechanical specifications:
   1. General Specifications:

a. Shall include an IDC type of termination for the cable. Crimp type terminations not acceptable.
b. Shall support cable gauges from 22 to 26 AWG
c. Shall include a rubber boot

2. Electrical Specifications:
a. ISO 9001 Certified Manufacturer
b. UL verified for EIA/TIA electrical performance
c. Comply with FCC Part 68
d. Cable termination: IDC type universal T568A or T568B.

B. Design selection: modular SCS jacks shall be selected according to the following criteria:
1. Performance requirement: Match performance of Modular SCS jacks

C. Approved manufacturer: Match selection for modular SCS jacks.

2.3 OTHER MODULAR JACKS

A. Whenever indicated in the design drawings SCS outlets could have terminations for other media types like fiber optic cables, coaxial cables or audio cables. Whenever those type of media are identified in the drawings, the following specifications shall be meet for modular jacks mounted in SCS outlets:
1. Style, mounting orientation and color: match design selection for modular SCS jacks.
2. Broadband distribution system connector: Use modular jack with F connector bulkhead rated at 75Ω.
3. Fiber optic connectors: use modular jack with adapter plate for LC duplex connector.
4. For line level audio signals: use modular jack with RCA connector bulkhead. Use different color coded insulators for different audio channels.

B. Approved manufacturer: Match selection for modular SCS jacks.

2.4 FACEPLATES

A. Faceplates shall be used for all flush mounted telecommunication outlets to house modular jacks. Faceplates shall have the following specifications:
1. Construction material: High impact thermo Plastic
2. Size: use single gang faceplates only unless specifically noted in the design drawings.
3. Capacity of modular jacks per faceplate: faceplate shall be selected as to accommodate the amount of cables in each telecommunication outlet. No more than one unused opening shall be present on each faceplate.
4. Color: submit color to A&E for approval.
5. Labels: faceplate shall have two (2) recesses for labels, top and bottom, and shall have transparent label snap-on covers.
6. Faceplate style: Direct modular plug rear loading style

B. Approved manufacturer: Match selection for modular SCS jacks.

1. Tripp Lite 4 Port – N042-001-04-WH
2. Tripp Lite 2 Port – N042-001-02-WH

2.5 FACEPLATES WITH SUPPORT STUDS

A. Telecommunication outlets indicated in the design drawings as to be wall mounted telephone outlets shall be composed of one modular SCS jack and one faceplate with support studs mounted on an electric box. Faceplates with support studs shall have the following specifications:
   1. Construction material: Stainless Steel.
   2. Size: use single gang faceplate with two support studs.
   3. Capacity of modular jacks per faceplate: One.
   4. Faceplate style: Direct modular plug rear loading style.

B. Approved manufacturer: Match selection for modular SCS jacks.

2.6 SURFACE MOUNTED BOXES

A. Telecommunication outlets indicated in the design drawings as to be surface mounted outlets shall be composed of modular jacks mounted in a surface mounted box inside an electrical enclosure. Surface mounted boxes shall have the following specifications:
   1. Construction material: High impact thermo Plastic.
   2. Capacity of modular jacks per surface mounted box: size of surface mounted box shall be selected as to accommodate the amount of cables in the surface mounted telecommunication outlet. No more than one unused opening shall be present on each box.
   3. Color: White.
   4. Labels: surface mounted boxes shall have at least one (1) recess for labels, and shall have transparent label snap-on covers

B. Approved manufacturer: Match selection for modular SCS jacks.

2.7 MOUNTING FRAMES

A. All telecommunication outlets shall be properly mounted in the electrical raceway system provided for the outlet. The SCS installer shall select the proper mounting frame and/or bezel to mount the modular plugs in the raceway system. Raceway systems include furniture systems, floor boxes, poke-thrus, power poles, surface raceways system, etc.

B. Whenever design drawings indicate a telecommunication outlet to be mounted in a furniture system the SCS Installer shall select the proper mounting frame to hold the modular jacks in the furniture system selected by the owner. Color of the mounting frames shall match the color of the furniture system.

C. If owner provided furniture system does not have a raceway system for telecommunication, and design drawings indicate outlet to be mounted in the furniture

system, SCS installer shall provide a plastic surface mounted box that allows the mounting of the modular plugs in a standard telecommunication faceplate.

D. SCS installer shall provide all mounting frames and bezels to mount modular jacks inside floor boxes or poke-thrus.

E. All un-used ports in mounting frames shall be covered with blank inserts.

F. Approved manufacturer: Match selection for modular SCS jacks.

2.8 HORIZONTAL 4-PAIR CABLE

A. General: Horizontal 4-pair cables shall be extended between the telecommunications outlet location and its associated equipment inside the TR. The cable shall consist of 4 pair cable solid copper conductors, certified to the specified performance standard. All horizontal 4-pair cables shall be terminated in modular jacks and patch panels with IDC type connectors and shall have the following specifications:
   1. Cable Gauge: minimum 23 AWG
   2. Performance standard: TIA/EIA CAT6A
   3. Cable type: UTP
   4. Performance characterized to: 600 MHz
   5. Time delay skew: Maximum 45 ns/100m
   6. Input impedance (1-100MHz): 100Ω
   7. Cable diameter: ≤ 0.295 inch

B. Cable jacket colors for 4-pair horizontal cables shall be selected according to the following criteria:
   1. Voice or data cables: Blue cable, white keystone
   2. Wireless access points: White cable, black keystone
   3. Surveillance cameras: Yellow cable, yellow keystone
   4. ICAC: Green cable, green keystone

C. Performance verification: All performance of horizontal 4-pair cable shall be verified by a Nationally Recognized Testing Laboratory (NRTL) for EIA/TIA electrical performance and comply with FCC Part 68.

D. Jacket: Cable jacket for inside premise cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.

E. OSP Jackets: All horizontal 4-pair cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable for this application.

F. Jacket marking: All horizontal 4-pair cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.

G. Approved manufacturer: Corning, Superior Essex, Belden, Panduit, Siemon, CommScope General Cable, or Berk-Tek.

2.9 PATCH PANELS FOR HORIZONTAL CABLING

A. All 4-pair horizontal cables shall be terminated in rack mounted path panel located in the telecommunication rooms rack. These patch panels shall have the following specifications.
   1. Connector type: 8-position modular plug (RJ-45)
   2. Cable termination: IDC type universal T568A or T568B.
   3. Performance requirement: CAT6A
   4. Maximum connectors per path panel allowed: 48
   5. Patch panel type: factory molded jacks to frame rear loaded panels
   6. Patch panel shape: straight (flat)
   7. Permanent marking: All connectors shall be labeled in sequential numbers
   8. Field labels: patch panels shall have a space for field labels covered with transparent protectors.
   9. Shielding: use shielded patch panels only with ScTP cable.

B. Approved manufacturers. Match selection for modular SCS jacks
   1. Tripp Lite Patch Panel – N062-024-KJ-SH

2.10 HORIZONTAL WIRE MANAGERS

A. Horizontal wire managers shall be mounted in racks to route cables from patch panels to vertical wire managers and to equipment. Horizontal wire managers shall have the following specification:
   1. Style: Finger duct style with hinged cover
   2. Sides: front of rack
   3. Minimum height: two RU

B. Approved manufacturers. Match selection for modular SCS jacks

2.11 FOUR (4) PAIR PATCH CORDS

A. Four (4) pair patch cords are required at the work area side and at the patch panel side to complete the connectivity path to the equipment. All 4-pair patch cords shall be factory tested and shall have molded boots to the cable jacket. Field made patch cords are not acceptable. Four pair patch cords shall have the following specifications:
   1. Connectors: 8-pin modular plugs at both ends
   2. Conductors: 4-pair stranded conductors.
   3. Wire gauge: 23AWG for patch cords in the field site and 28 AWG for patch cords in the telecom room side
   4. Wiring map: See section 3 of this specification
   5. Performance requirement: To match horizontal 4-pair cable performance
   6. Cable type: UTP

B. Approved manufacturers. Match selection for modular SCS jacks

2.12 SINGLE STRAND FIBER OPTICS CONNECTORS

A. All fiber optic cables (horizontal or backbone cables) shall be terminated on fiber optic connectors at both ends of the cable with either single strand fiber optic connectors or array connectors. Single strand fiber optic connector shall be compliant with industry standard ANSI/TIA-568-C.3 and the applicable TIA/EIA Fiber Optic Connector Intermateability Standard (FOCIS) document, TIA/EIA 604 series. Single strand fiber optic connectors shall have the following specification:
   1. Physical contact type: use UPC type connector for all application with the exception of applications of Broadband TV distribution systems or DAS systems. For those applications use APC type connectors.
   2. Connector type: LC
   3. Security level: non-keyed connector
   4. Pairing style: duplex
   5. Acceptable connector attachment types:
      a. Epoxy type connectors, field polished
      b. Epoxy less (Crimp) type connector, field polished.
      c. Splice on connectors. Fusion spliced connectors with factory polished finish.
      d. Fusion spliced pig tail with factory polished connector. Mechanical splices for pig tails are not acceptable.
   6. Fiber type: SCS installer shall select the connector according to the fiber type where connector will be installed. As an example use OM1 connectors only in OM1 fiber optic cables.
   7. Fusion spliced pig tails. When using fusion spliced pig tails the SCS installer shall make sure the fiber type of the pig tail and the actual cable have the same optical characteristics, such as back scatter, core diameter, etc.
   8. Ferrule construction: use ceramic ferrule connectors only, plastic ferrules are not acceptable.

B. All single strand fiber optic connectors shall include boots to protect the fiber optic cable. The SCS installer shall select the boot according to the fiber optic type selected. As an example use 900µm boots in 900µm coated fiber, use 250µm boots on 250µm coated fiber and use 2mm boots on 2mm jacketed fiber. All boots shall be color coded to identify the type of fiber connector used. Boots shall be beige for OM1 fiber, black for OM2, aqua for OM3 and OM4 or green.

C. Single strand multimode fiber optic connectors shall have the following performance requirements:
   1. The maximum insertion loss shall be 0.75 dB (maximum) when installed in accordance with the manufacturer’s recommended procedure and tested in accordance with FOTP-171.
   2. Connector reflectance shall be less than or equal to -26 dB when installed in accordance with the manufacturer’s recommended procedure.
   3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.

4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90º angle, with a maximum 0.5dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA-455-6B.

D. Single strand single mode fiber optic connectors shall have the following performance requirements:
1. Maximum insertion loss shall be 0.75 dB per each mated connector pair when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
2. Connector reflectance shall be less than or equal to -40 dB (UPC) when installed in accordance with the manufacturer's recommended procedure.
3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90º angle, with a maximum 0.5 dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA-455-6B.
5. Connectors shall meet the following performance criteria:

Test	Procedure	Maximum Attenuation Change (dB)
Cable Retention	FOTP-6	0.2dB
Durability	FOTP-21	0.2 dB
Impact	FOTP-2	0.2 dB
Thermal Shock	FOTP-3	0.2 dB
Humidity	FOTP-5	0.2 dB

E. Approved manufacturers: Ortronics, Corning, Belden, Panduit, Siemon, Leviton, CommScope or 3M

2.13 FIBER OPTICS SPLICES

A. When fiber splicing is required in the project because of the use of pigtails or field splicing, only fusion splicing will be acceptable. Mechanical splices shall not be used unless specifically indicated in the contract documents.

B. All fiber splices shall be terminated with heat shrink sleeves and organized in splice trays. Splice trays sizes shall be selected to match the quantity of fiber strands in the cable bundles. Splice trays shall be organized in Fiber Optics Distribution Centers when inside a telecom room or in outdoor rated splice closures when done outdoors.

C. Fusion splice equipment to be used in this project shall have the following specifications:
1. Alignment system: Automatic Core Detection system (ACD). V-groove splicers are not allowed.
2. Typical splice loss for single mode fibers: 0.02 dB
3. Splice loss result: Estimated (ACD)
4. Unit shall have a fast heat shrink oven, maintenance free electrodes, built in cleaver and graphical user interface to display alignment condition.
5. Cleaver blade type: diamond.

2.14 INSIDE PREMISE FIBER OPTICS HORIZONTAL CABLES

A. Telecommunications outlets could have fiber optic terminations. Whenever design drawings indicate fiber optic terminations, inside premise fiber optic horizontal cables shall be used. The following are the specifications for fiber optic horizontal cables:
   1. Strand Count: As indicated in design drawings
   2. Fiber type: As indicated in design drawings
   3. Fiber coating: 900µm coating color coded
   4. Fiber protection: aramid yarn
   5. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
   6. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.

B. Jacket: Cable jackets for fiber optic cables shall comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated. Rating shall be printed in the cable jacket.

C. OSP Jackets: All fiber optic horizontal cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable with this application.

D. Approved manufacturers. Match selection for horizontal 4-pair cable

2.15 INSIDE PREMISE FIBER OPTICS BACKBONE CABLES

A. Whenever design drawings indicate fiber optics backbone cables to be run inside premises, the following specification shall be followed for those cables:
   1. Strand Count: As indicated in design drawings
   2. Fiber type: As indicated in design drawings
   3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable.
   4. Fiber protection: aramid yarn around all strands for cables under 24 strands, and aramid yarn and jacket around each subunit (6 or 12 strands) for cables above 24 strands.
   5. Interlock requirement: Interlock aluminum armor is not required
   6. Jacket type: Flame-retardant PVC jacket or materials with superior performance.
   7. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.
   8. Fiber termination: fibers shall be field terminated
   9. Buffer type: tight buffer required.
   10. Center strength member material: dielectric material

B. Jacket: Cable jackets for fiber optic cables shall comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer

shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.

C. Approved manufacturers: Match selection for horizontal 4-pair cable

2.16 OUTSIDE PLANT FIBER OPTICS BACKBONE CABLES

A. Whenever design drawings indicate fiber optics backbone cables to be run between building or outside premises, the following specification shall be followed for those cables:
   1. Strand Count: As indicated in design drawings
   2. Fiber type: As indicated in design drawings
   3. Fiber coating: 250µm coating protected with break-out kits with color coded 900µm buffers at both ends of the cable when cables are terminated in conditioned spaces. When fibers are terminated in outdoor non-conditioned spaces break out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
   4. Rodent protection requirement: required
   5. Buffer type: Loose tube.
   6. Center strength member material: dielectric material

B. Jacket: All outside plant fiber optics backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with following standards:
   1. ANSI/TIA-568-C
   2. Telcordia GR-20
   3. ANSI/ICEA S-87-640

C. Approved manufacturers. Match selection for horizontal 4-pair cable.

2.17 INDOOR/OUTDOOR FIBER OPTICS BACKBONE CABLES

A. Whenever design drawings indicate indoor/outdoor fiber optics backbone cables to be run between buildings or outside premises, the following specification shall be followed for those cables:
   1. Strand Count: As indicated in design drawings
   2. Fiber type: As indicated in design drawings
   3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable. When fibers are terminated in outdoor non-conditioned spaces break out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
   4. Rodent protection requirement: required
   5. Buffer type: tight buffer required loose buffer acceptable.
   6. Center strength member material: dielectric material

B. Jacket: All indoor/outdoor fiber optics backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with following standards:
   1. ANSI/TIA-568-C
   2. Telcordia GR-409
   3. ANSI/ICEA S-104-696

C. Jacket: Cable jackets for indoor/outdoor fiber optic cables shall also comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.

D. Approved manufacturers. Match selection for horizontal 4-pair cable

2.18 FIBER OPTIC DISTRIBUTION CENTERS

A. All fiber optic cables shall be terminated in fiber optic distribution centers. Inside premises horizontal fiber optic cables shall be terminated in one side (telecommunication room side) in a fiber optics distribution center (FODC). Backbone fiber optic distribution centers shall be terminated at both ends in a FODC. FODC are composed of an enclosure and snap on adapters. These are the specifications of the enclosures for the FODC:
   1. Mounting: Use rack mounted FODC enclosures in all rooms where racks are available or any type of rack rails. Use wall mounted FODC enclosures only when racks are not available like in outdoor enclosures, or other spaces different than telecom rooms.
   2. Size: SCS Installer shall size the FODC based on the amount of fiber strands to be terminated in the FODC.
   3. Front locking doors are required.
   4. Locking door shall be transparent doors and shall have labeling cards.
   5. Whenever fiber splices are indicated in the design drawings next to an FODC, enclosures shall be selected by the SCS installer as to have spaces to hold splice trays. FODCs under these conditions shall be able to hold the amount of splice trays required for the fiber count indicated in the drawings.

B. These are the specifications of the snap on adapters for the FODC:
   1. Style: plate style
   2. Connector type: LC to match fiber types of fiber optic cables
   3. Maximum fiber strands allowed per adapter: 24
   4. Security level: non-keyed connector keyed connector
   5. Pairing style: duplex

C. Approved manufacturers. Match selection for fiber optic connectors

2.19 FIBER OPTICS PATCH CORDS

A. Fiber optic patch cords shall be required for connections from active equipment to FODCs and/or to telecommunication outlets. Fiber optic patch cords shall be required at both ends of fiber optics backbone cables or horizontal fiber optic cables. Direct connection of backbone cables or horizontal fiber optic cables to active equipment shall not be allowed.

B. Fiber optic patch cords shall be all factory tested. Field made fiber optic patch cords are not acceptable. The specifications of the fiber optic patch cords shall be:
   1. Strand Count: 2 strands
   2. Fiber type: Match fiber type of backbone cable or horizontal cable.
   3. Fiber connector in FODC or outlet side: match connector for each adapter
   4. Fiber connector in active equipment side: the SCS installer shall coordinate with supplier of equipment the type of connector required in this side.
   5. Fiber protection: aramid yarn
   6. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
   7. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.

C. Approved manufacturers. Match selection for fiber optic connectors

2.20 INSIDE PREMISE MULTIPAIR BACKBONE CABLES

A. Whenever indicated in the drawings multipair backbone cables to be run inside premises and above grade shall have the following specification:
   1. Pair count: as indicated in the design drawings
   2. Conductor: AWG 24 solid bare copper conductor
   3. Input impedance: 100 Ω
   4. Conductor insulation: color coded thermo plastic
   5. Performance requirement: UL verified to ANSI/TIA-568-C Category 3 backbone cable.

B. Jacket: Cable jacket for inside premise multipair backbone cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.

C. Jacket marking: All inside premise multipair backbone cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.

D. Approved manufacturer: Belden, Superior Essex, General Cable, Berk-Tek or CommScope.

2.21 OUTSIDE PLANT MULTIPAIR BACKBONE CABLES

A. Whenever indicated in the drawings outside plant multipair backbone cables to be run between buildings or inside premises but below grade shall have the following specification:
   1. Pair count: as indicated in the design drawings
   2. Conductor: AWG 24 solid bare copper conductor
   3. Input impedance: 100 Ω
   4. Conductor insulation: Solid polyolefin; color coded in accordance with industry standards.
   5. Performance requirement: UL verified to ANSI/TIA-568-C Category 3 backbone cable.
   6. Shield: Corrugated, copolymer coated, 8 mil aluminum tape applied longitudinally with an overlap; flooded shield interfaces.
   7. Jacket: Black, polyethylene

B. Jacket: All outside plant multipair backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant multipair backbone cables shall be tested and in compliance with following standards:
   1. ANSI/ICEA S-84-608-2007
   2. RDUP 7 CFR 1755.390 (PE-39)
   3. RoHS-compliant

C. Approved manufacturer: Match selection for inside plant multipair backbone cables.

2.22 TERMINATION OF MUTIPAIR BACKBONE CABLES

A. Backbone multipair backbone cables for inside premises or outside plant shall be terminated in termination blocks or patch panels. See design drawings for specific types on each case.

B. Whenever indicated in the design drawings, multipair backbone cables shall be terminated in patch panels. Patch panels for this purpose shall have the following specifications:
   1. Connector type: 8-position modular plug (RJ-45)
   2. Connector wiring map: One pair per connector pins 4 and 5 (blue pair).
   3. Cable termination type: IDC type connector
   4. Performance requirement: CAT3
   5. Maximum connectors per path panel allowed: 96
   6. Permanent marking: All connectors shall be labeled in sequential numbers
   7. Field labels: patch panels shall have a space for field labels covered with transparent protectors.
   8. Shielding: Unshielded.

C. Whenever indicated in the design drawings, multipair backbone cables shall be terminated in rack mounted termination blocks. Termination blocks for this purpose shall have the following specifications:
   1. Connector type: 110 style connector
   2. Cable termination type: IDC type connector

3. Performance requirement: CAT3
4. Rack frame: standard 19” rack.
5. Pair counts: use 100 pair blocks for backbone cables under 100 pairs. Use 200 pair blocks in quantities as required for backbone cables with over 200 pairs.
6. Wire managers: All 200 pair termination blocks shall have a 2 RU wire manager built-in.
7. Clip types: Use 110C4 clips or 110C5 clips.
8. Field labels: termination blocks shall have a space for field labels covered with transparent protectors.
9. Mounting: termination block shall be mounted without legs in the rack plate.

D. Whenever indicated in the design drawings, multipair backbone cables shall be terminated in wall mounted termination blocks. Termination blocks for this purpose shall have the following specifications:
1. Connector type: 110 style connector
2. Cable termination type: IDC type connector
3. Performance requirement: CAT3
4. Pair counts: Use only 300 pair blocks in quantities as required for backbone cables.
5. Wire managers: All termination blocks shall have a wire manager installed at both sides of the blocks and between blocks.
6. Clip types: Use 110C4 clips or 110C5 clips for 110 style block.
7. Field labels: termination blocks shall have a space for field labels covered with transparent protectors.
8. Mounting: termination block shall be mounted with legs on the wall.

E. Approved manufacturers. Match selection for modular SCS jacks

2.23 SITE COPPER PROTECTORS

A. General: When required by NEC or when indicated in the drawings copper circuits shall be provided with protection between each building with an entrance cable protector chassis. All building-to-building circuits shall be routed through this protector. Protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TR ground point.

B. General: Primary protection units shall be composed of a cabinet that supports 5-pin protection modules and termination blocks. The cabinet for protection unit shall have the following specifications:
1. Capacity: 100 pairs
2. Socket type: 5-pin modules
3. Input mode: 110 style IDC connector.
4. Output mode: 110 IDC
5. Grounding lug capacity: AWG 6 to AWG 14
6. Other: stand-off bracket required.

C. The protector unit for digital lines shall have the following specifications:
1. Mounting type: 5-pin module
2. Protection type: Solid state MOV
3. Pairs per unit: one

4. Protection type: heat coil and sneak current protection
5. DC Breakdown Voltage @ 2kV/sec: 60-90 V
6. Surge Breakdown Voltage @100 V /µsec: 220-300 V
7. Insulation Resistance (PE-80): > 100 M Ω
8. DC Holdover Current: 260 mA/52 V
9. On-State Voltage @ 75 A: < 10 V
10. Response Time: < 100 nsec
11. Rated Impulse Discharge: 100 A
12. Capacitance(VDC=50 V, f=1 kHz, V AC=1 Vrms): < 100pF
13. Line Series Resistance: < 4 Ω
14. Sneak Current Operation (heat coils): 540 mA <210 sec, 1 A <15 sec
15. Listing: UL 497

D. The protector unit for analog lines shall have the following specifications:
1. Mounting type: 5-pin module
2. Protection type: Solid state MOV
3. Pairs per unit: one
4. Protection type: heat coil and sneak current protection balanced
5. DC Breakdown 240 V

E. Approved Manufacturers for primary protectors: Commscope, Tii, Circa and Emerson

F. All primary protection block shall be used with a secondary protection block. The secondary protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TR ground point. Secondary protection shall have the following specifications:
1. Style: Mounted on a 66-type block
2. Protection type: solid state and fuse protection
3. Pairs per unit: one
4. Breakdown voltage: selected by SCS installer according to signals protected
5. Maximum number of protectors per block: 25
6. Listing: UL 497A

G. Approved Manufacturers for secondary protectors: Commscope, Emerson, Siemon

2.24 PATCH CORDS FOR MULTIPAIR BACKBONE CABLES

A. Patch cords shall be used to connect horizontal wiring to termination blocks for multipair backbone cables. Depending on the type of termination for backbone cables, the patch cord shall be selected.

B. When multipair backbone cables are terminated in patch panels, patch cords for these patch panels shall have the same specification as the 4-pair patch cord cables described above.

C. When multipair backbone cables are terminated in wall mounted or rack mounted termination blocks, patch cords shall have a patch plug connector in one end and an 8-pin modular plug (RJ-45) in the other end. The SCS installer shall coordinate with the phone system installer and determine if one pair or two pairs are required for each phone.

Patch cords shall have one or two pairs according to the equipment selection. Patch plugs shall only be one or 2 pairs accordingly. Patch plug selection shall match the manufacturer and family of products of the termination blocks.

2.25 EQUIPMENT CABINETS

A. Whenever indicated in the design drawings equipment cabinets shall be provided as shown. Equipment cabinets shall be made of all welded steel frames and shall have a powder coat finish. Equipment cabinets shall have the following specifications:
   1. Cabinet construction material: Welded and bolted steel frame.
   2. Footprint: As indicated in design drawings 31”x42” ±1”
   3. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
   4. Rack rails type: standards EIA 19” square holes with cage nut rail located in the front and back of cabinet. Rack rails shall be adjustable for depth and shall have RU marked and labeled.
   5. Rack screw type: cage nuts clipped to rack rails. Nuts and screws shall be provided for all slots in rack rails and shall be made of steel threaded as #10-32.
   6. Side panels (end of row cabinet sides): solid steel, removable and lockable side panels.
   7. Side panels (between adjacent cabinets): solid steel, removable panels with openings for passing cables, covered with plastic removable caps, rubber caps or brush openings. No less than Eight (8) openings in total area of the side of the cabinet. Each opening shall be no less than 34 sq inches.
   8. Top panel: solid steel with no less than four (4) brush protected openings for cables. Each opening shall be no less than 34 sq inches.
   9. Bottom panel: solid steel with no less than two (2) brush protected openings for cables. Each opening shall be no less than 34 sq inches. For cabinets with top exhaust duct, a bottom air director shall be provided in the back side of the cabinets to force air up towards the exhaust duct.
   10. Door hinge supports shall be provided at both sides of the racks and front and back to be able to reverse doors.
   11. Grounding: Prepared location for ground lug at the top and bottom of the cabinet frame. Door shall include bonding jumper to cabinet.
   12. Weight capacity: UL listed for 2500 lb
   13. Finish: Epoxy-polyester hybrid powder coat paint on frame, rails, panels and metal accessories:
   14. Finish color: Black for all parts of the cabinet

B. Equipment cabinets shall be provided with the following accessories:
   1. Front 78% perforated panel hinged door with key lock.
   2. Rear 78% perforated panel split hinged doors with lock.
   3. Locking system: locks for front and rear doors shall be two point latching locks and shall be keyed identically for front and rear lock. All locks for cabinets for each user ground shall be keyed alike but different between user groups.
   4. Leveling feet and any accessories required to be able to bolt the cabinet to the floor with ½” screws or rods.
   5. Vertical wire managers covering the full height of the rack rails. Two in the front. Vertical wire managers shall be selected as recommended by equipment cabinet manufacturer to avoid obstructions to rack rails or doors. Vertical wire managers

shall have brush openings to run cables between front and back of cabinet and shall have all openings sealed to avoid air leakage between front and back.

6. Steel top exhaust duct, made of two separate sections to allow adjusting the height. Installer shall confirm final ceiling height in the room and order these ducts in a length as to provide adjustment for no less than 2” above and below of the final ceiling height. Top exhaust section shall have a rubber gasket to allow for good seal in ceiling imperfections.
7. Filler panels: For all racks with SCS installer provided equipment, all un-used rack spaces shall be covered with filler panels to avoid any air flow between front and back of cabinet. For all racks with owner provided equipment, the installer shall provide no less than 50% of all rack spaces in all racks with filler panels to prevent air flow between front and back of cabinet. All cabinets with no equipment installed at the end of the project shall have the front door wrapped with plastic wrap to prevent any air flow through the cabinet.
8. Air dam: The cabinet shall be provided with an air dam blocks airflow around the sides and top of the equipment mounting space, so cold air passes through equipment and hot air does not re-circulate around equipment. Any other additional type of seal required to prevent air flow from the front of the cabinet to the back shall be provided.
9. PDU bracket: PDU brackets shall be provided in each cabinet according to the number of vertical PDUs programmed to be installed in each cabinet. See drawings for quantities. These brackets shall be selected by the SCS installer as to match the support holes of the PDU selection for each cabinet.
10. All cabinets with equipment installed with substantial amount of cables terminating in the rear of the equipment, such as audio/visual systems and security systems shall be provided with enough cable lashing metal brackets to strap all cables to the frame for proper organization and support.
11. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8” thick and 1” wide with threated holes 1032 mounted to the cabinet using nylon insulation washers

C. Required equipment cabinet certifications: Complaint with EIA 310-E and UL 2416 listed

D. Airflow re-director: The manufacturer of the equipment cabinet shall offer an air flow re-director kit for the type of cabinet selected for this project to allow for changing air flow direction of equipment designed for side to side ventilation. The SCS installer shall provide air flow re director kits for all cabinets in the plans with Core switches or network equipment.

E. Field cuts or openings. Any cabinets with field cuts or perforations will be rejected and the SCS installer shall provide a new cabinet to remedy the condition.

F. Approved manufacturer: Panduit, Ortronics, Eaton, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal.

2.26 QUAD POST RACKS

A. Whenever indicated in the design drawings quad post racks shall be provided as shown. Quad post racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Quad post racks shall have the following specifications:
   1. Depth adjustment: rack rails shall be adjustable from 12.5” to 36” in depth, independent of the structural members allowing racks rails adjustment after racks are anchored.
   2. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
   3. Rack rails type: standards EIA 19” square holes located in the front and back of rack. Rack rails shall have RU marked and labeled.
   4. Rack screw type: cage nuts clipped to rack rails. Nuts and screws shall be provided for all slots in rack rails and shall be made of steel threaded as #10-32.
   5. Weight capacity: UL listed for 1200 lb or more.

B. Quad post racks shall be provided with the following accessories:
   1. Base dust covers that prevent accumulation of dust and debris in rack base.
   2. Cable runway mounting brackets to support cable runway installed above racks
   3. Isolation pads.
   4. Grounding kit.
   5. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threated holes 1032 mounted to the cabinet using nylon insulation washers
   6. End panels to support vertical wire managers at the end of each rack row.

C. Front vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
   1. Style: Metal cage with dual hinged door cover
   2. Sides: single sided wire manager (front only).
   3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in
   4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.

D. Rear vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
   1. Style: Metal cage with dual hinged door cover
   2. Sides: single sided wire manager (rear only).
   3. Capacity: Usable cross sectional area shall be a minimum of: 130 sq-in
   4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.

E. Approved manufacturer: Match selection for Equipment Cabinets Tripplite.

2.27 TWO POST RACKS

A. Whenever indicated in the design drawings two post racks shall be provided as shown. Two post racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Two post racks shall have the following specifications:
   1. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
   2. Channel depth: 3” ± 1”
   3. Rack rails type: standards EIA 19” located in the front and back of rack. Rack rails shall have RU marked and labeled.
   4. Rack screw type: #12-24 threaded rack rails. Screws shall be provided for all openings in rack rails and shall be made of steel.
   5. Weight capacity: UL listed for 1000 lb or more.

B. Two post racks shall be provided with the following accessories:
   1. Cable runway mounting brackets to support cable runway installed above racks
   2. Isolation pads
   3. Grounding kit.
   4. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threated holes 1032 mounted to the cabinet using nylon insulation washers
   5. End panels to support vertical wire managers at both ends of each rack row.

C. Front vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
   1. Style: Metal cage with dual hinged door cover
   2. Sides: single sided wire manager or dual side wire manager.
   3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in
   4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.

D. Rear vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
   1. Style: Metal cage with dual hinged door cover
   2. Sides: single sided wire manager (rear only) or if dual side wire front managers are included, no need for rear vertical wire managers.
   3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-
   4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.

E. Approved manufacturer: Match selection for Equipment Cabinets Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal.

2.28 WALL MOUNTED RACKS

A. Whenever indicated in the drawings, wall mounted racks shall be provided as indicated. Wall mounted racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Wall mounted racks shall have the following specifications:
   1. Style: Swing out reversible cabinet
   2. Height: As indicated in design drawings.
   3. Depth: it is the responsibility of the SCS installer to select a cabinet that will fit all equipment to be installed in the racks, either provided under this contract or by the owner. Approval of submittals by the A&E does not relief the SCS installer of the responsibility of verifying this requirement. Racks that will not fit the equipment shall be replaced at no additional cost to the owner.
   4. Rack rails type: standards EIA 19” located in the front. Rack rails shall be adjustable and shall have RU marked and labeled.
   5. Rack screw type: #12-24 threaded rack rails. Screws shall be provided for all openings in rack rails and shall be made of steel.
   6. Weight capacity: UL listed for 200 lb or more.

B. Wall mounted racks shall be provided with the following accessories:
   1. Solid door with lock. Door shall be hinged and shall be reversible.
   2. Fan kit composed of two 4” fans and fan guards.
   3. Additional rack rails shall be provided when equipment with a different of 2” in front depths are to be mounted in the rack. Front depth is defined as the distance between the front of the rack ears and the front of the equipment, including space for connectors or bend radius of cables.
   4. Grounding kit.
   5. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threated holes 1032 mounted to the cabinet using nylon insulation washers.

C. Approved manufacturer: Match selection for Equipment Cabinets Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal.

2.29 MEDIA CONVERTERS

A. General. When telecommunications outlets exceed distance limitations to pass testing requirements, the SCS installer shall provide media converters and fiber optics connectivity to overcome this problem. The media converters shall have the following specifications:
   1. Power: All power for media converters in the field end (i.e. camera or WAP side) shall be powered from the Telecom room side using a hybrid cable. Local power adapters for media converters are not acceptable in the field end.
   2. Cabling: A composite cable shall be used for these devices. This composite cable shall have a minimum of 2 strands of fiber optics and 1 pair of copper cable AWG-12 for the remote end power. The quantity of fiber strands for this cable shall be as required by the type of media converter used. The fiber types shall be as required by the media converter. The cable jack for this composite cable shall be

selected as required for the application. Any cables being pulled underground shall have a water blocking jacket.

3. Port count: Media converters with 1 port or 4 ports are acceptable.
4. PoE support: Media converters shall support PoE without the need of an external power adapter and the field end.
5. Fiber connection speed. Media converters shall support 1GB connections in the fiber port.
6. PoE capacity: Media converters shall support PoE+ (30W) for all outdoor cameras and all WAPs. Media converter shall support 15,4 W for all other PoE devices.
7. Power supplies: Media converters shall be provided with the corresponding power supplies at the telecom room.

B. Basis of design; Berk-Tek One Reach solutions or similar.

2.30 CABLE TIES

A. Cable ties shall be used at different locations of the project but with the same goal of producing a neat and organized installation. Cable ties shall be used to support cables to j-hooks (when j-hooks are allowed in the project) to organize cables in ladder trays, D-rings and cable trays, to support cables to wire managers including managers behind patch panels, to bundle cables, organize patch cords, etc.

B. To support and organize all horizontal cabling and inside premise backbone cables, only the following types of cable ties shall be used:
1. Hook and loop style, re-usable with Velcro no smaller than 0.5” width.
2. Pre-perforated rolls of re-usable ties with Velcro no smaller than 0.5” width
3. Straps of other soft materials with cinch rings that allow for re-use of the cable ties in widths no smaller than 0.85”.

C. Nylon based cable ties (re-usable or not) can only be used to support and organize the following types of cables:
1. Outside plant fiber and copper backbone cables.
2. Inside premise fiber optic backbone cables with interlock armors.
3. Grounding conductors

D. Nylon based cable ties shall never be used to support or organize any type of horizontal cables or inside premise fiber optic backbone cable without armor.

E. All cable ties to be used in outdoor environments shall be made of weather resistant Acetal. Outdoor cable ties used for aerial cable lacing shall be in compliance with Telcordia TR-TSY-000789 standard.

F. All cable ties shall be selected in lengths as to properly secure the bundle of cable being supported.

G. All cable ties to be used in air handling spaces, such as above ceiling and under raised floor areas, shall be UL listed for the use in those environments.

H. Approved manufactures: Ortronics, Panduit or approved equal

2.31 IDENTIFICATION AND LABELING TAGS

A. SCS installer shall follow labeling materials indicated in specification section 27 00 10.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. GENERAL. All installation requirements indicated in specification section 270010 shall be followed.

B. WORKMANSHIP. All work shall be completed by the SCS installer in a neat and workmanlike manner. The use of all BICSI standards and recommendations for installation shall be followed as the benchmark for workmanship.

C. CABLE LENGTHS. It is the SCS installer’s responsibility to plan the cable routing in the cable tray and other raceways as to minimize all cable runs to be able to stay under the 90 meter (295 ft) length limitation for Horizontal Cabling. All cable runs exceeding the wiring distance, due to raceways run in not the most efficient way to minimize distance, shall be re-run with horizontal fiber optic cables and with media converters, at no extra cost to the owner.

D. WIRE MAPPING. All terminations of 4-pair horizontal cabling in this project and terminations of all 4-pair patch cords shall be per T568B standard.

E. FIBER OPTICS TERMINATION POLARITY. All fiber optic cables (horizontal or backbone) terminated in duplex style adapter panels shall be connected in a cross-over polarity configuration. As an example, if fibers 1 and 2 are terminated in one end in positions A and B respectively in one side of the cable, the same strands shall be terminated in B and A positions in the other side of the cable.

F. POLARITY FOR FIBER OPTICS ARRAY CONNECTORS. Array connectors and cassettes for this project shall use Method C polarity system as outline in TIA-568.B.1

G. LOCATION OF HORIZONTAL TERMINATIONS. In a multi-story facility with telecommunications room in every floor, all horizontal drops, whether terminated in the wall or in floor boxes shall be terminated in the same floor telecommunications room as the location of the final outlet.

H. CABLE BUNDLES. In suspended ceiling and raised floor areas if duct, cable trays or conduits are shown on the contract drawings, the SCS installer shall bundle, in bundles of 40 or less, horizontal wiring with cable ties snug, but not deforming the cable geometry. The cable bundling shall be supported via "CLIC" fasteners in TR’s and non-plenum areas and J-hooks in ceiling spaces. The SCS installer shall adhere to the manufacturers' requirements for bending radius and pulling tension of all cables.

I. CLIC FASTENERS. Horizontal cables shall be suspended by "CLIC" fasteners with cable inserts in TR’s on the plywood area where ladder tray or rack management is not

available per the design documents. Listings: "CLIC" fasteners shall be in accordance with NEC and BICSI standards. Above the plywood area J-hooks or D-rings should be used.

J. FIRE STOP PROTECTION. Sealing of openings between floors, through rated fire and smoke walls, existing or created by the SCS installer for cable pass through shall be the responsibility of the SCS installer. Sealing material and application of this material shall be accomplished in such a manner, which is acceptable to the local fire and building authorities having jurisdiction over this work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the SCS Installer's work. Any openings created by or for the SCS installer and left unused shall also be sealed as part of this work. Penetration rating shall equal structure rating.

K. NEW MATERIALS. All components, wiring and materials to be used for the installation of the SCS shall be new and free of defects. Used components, wiring and materials shall only be used when specifically indicated in the design drawings.

L. DAMAGE. The SCS Installer shall be responsible for any damage to any surfaces or work disrupted as a result of his work. Repair of surfaces including painting and ceiling tile replacement shall be included as part of this contract.

M. AVODING EMI. To avoid EMI, all pathways shall provide clearances of at least 4 feet (1.2 meters) from motors or transformers; 1 foot (0.3 meter) from conduit and cables used for electrical-power distribution; and 5 inches (12 centimeters) from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The SCS installer shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

N. WORK EXTERNAL TO THE BUILDING. Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification.

O. DEMOLITION. Any task part of the installation of the SCS requiring relocation, rerouting and/or demolition shall be done according to the following requirements:
   1. Coordination: Prior to any deactivation and relocation or demolition work, arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused or to remain in operation and be integrated with the new systems.
   2. Provisions: All deactivation, relocation, and temporary tie-ins shall be provided by the SCS installer. All demolition, removal and the legal disposal of demolished materials of system designated to be demolished shall be provided by the SCS installer.
   3. All Existing Voice/Data cables and connecting hardware not to be used after the new installation is complete and within the areas where work is required as part of this project shall be removed by the SCS installer. All existing cables to be left for future use if indicated by the owner shall be tagged for that purpose.

4. Owners Salvage: The Owner reserves the right to inspect the material scheduled for removal and salvage any items he deems usable as spare parts.
5. Phasing: The SCS installer shall perform all work in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.

P. ICONS. Faceplates, jacks or patch panels with inserts for icons shall be filled with icons when unit capable of accepting icons. Icons in the work area side (outlet) shall match the color of the faceplate. Icons for path panels shall match the color of the horizontal cabling.

Q. BLANK INSERTS AND PANELS. All telecommunications outlets with faceplates or mounting frames with unused terminations shall be plugged with blank inserts or panels. Blank inserts shall match the color of the faceplate or mounting frame. No more than one blank module shall be required for each faceplate. All unused ports in the FODC enclosures for adapter panels shall be filled with blank adapter panels.

R. PATCH PANEL AND FODC SEPARATION: Horizontal cables shall be terminated in separate patch panels according to the use of the cable. Each series of patch panels or FODC for a specific use shall have at least 20% spare capacity of ports. Patch panels of the same use shall be mounted consecutive in the equipment cabinets or racks. The following separation for patch panels and FODCs shall be provided:
1. Cables for Wireless Access Points (WAPS) shall be separated from cables for any other purpose.
2. Cables for surveillance cameras shall be separated from cables for any other purpose.
3. Cables for voice drops shall be separated from cables for data drops.
4. Cables for any other specialty systems like security systems, nurse call systems or others shall all be terminated in separate patch panels from any other cables.
5. Horizontal fiber optic cables shall be terminated in separate FODC from fiber optics backbone cables.
6. Single mode fiber optic backbone cables shall be terminated in separate FODC from multimode fiber optic backbone cables.

S. SUPPORTS FOR REAR OF PATCH PANELS. All patch panels for horizontal cables shall be provided with a rear support bar to hold the cable and to provide strain relief. At a minimum one rear support bars shall be provided for each two rows of 24 connectors.

T. HORIZONTAL WIRE MANAGERS. Horizontal wire managers shall be provided following this criteria:
1. At least one above and below each straight (flat) patch panel.
2. At least one top and bottom of each series of angled or curved patch panels.
3. At least one above and below any network switches.
4. At least one below any rack mounted termination block.

U. CROSS OVER WIRE MANAGERS. Cross over wire managers shall always be used with angled or curved patch panels. One cross over wire manager shall always be installed in the middle of each rack at the same height on every rack.

V. CABLE SLACK. Cable slack shall be provided for all cables in the project following this guideline:
   1. At each work area outlets, all horizontal cables shall have 12” of slack.
   2. At the telecom room side all horizontal cables shall have at least 6’ neatly organized on the wall using a figure 8 configuration or a non-loop shaped arrangement with Velcro straps.
   3. Backbone cables at termination points shall have at least 15’ of slack neatly organized on the wall using a standard loop and Velcro straps.
   4. Outside plant backbone cables run through in-ground pull boxes greater than 24”X24” shall include one service loop inside the box.

W. BEND RADIUS. Installation of Fiber Optic Cables shall be in accordance with ANSI/TIA-568C guidelines and cable manufacturer specifications. Bend radius parameters shall be followed for load and no load conditions. Cable installation and terminations that do not comply shall be replaced by the SCS installer. If no recommendation is specified by cable manufacturer, at least the following criteria shall be meet:
   1. The bend radius for intrabuilding 2 and 4-fiber horizontal optical fiber cable shall not be less than 25 mm (1 in) under no-load conditions. When under a maximum tensile load of 222 N (50lbf), the bend radius shall not be less than 50 mm (2 in).
   2. The bend radius for intrabuilding optical fiber backbone with fiber counts above 4 shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 15 times the cable outside diameter when the cable is under tensile load.
   3. The bend radius for intrabuilding optical fiber backbone shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 20 times the cable outside diameter when the cable is under tensile load up to the rating of the cable, usually 2670 N (600lbf).

X. INNERDUCT. Innerduct shall be provided from end to end of a raceway system under the following conditions:
   1. Inside underground conduits as indicated in design drawings.
   2. For horizontal fiber optic cable or inside premise fiber optics backbone cables without interlocking armor when routed through cable trays, ladder trays, vertical conduit sleeves or conduits larger than 3”. This requirement is usually not indicated in the drawings but indicated only in this specification.

Y. SCS PROTECTION DURING CONSTRUCTION. The SCS installer shall protect all SCS materials from damage during construction.Racks shall be covered with fabric or plastic after mounting to prevent dust, debris and other foreign materials having contact with SCS devices. The SCS installer shall protect at all times all fiber optic and copper cables from damage during installation. All cables shall maintain the physical integrity as manufactured for testing and delivery to the owner. All damaged cables shall be replaced at no additional cost to the owner.

Z. CABLE BONDING. Shielded cables or cables with metal strength or protection members (like interlocking armor) shall be bonded to the telecommunications grounding system as indicated in specification section 27 05 26.

AA. RACK INSTALLATION. All racks shall be installed leveled and plumbed. Four post racks and two post racks shall be anchored to the floor and shall be installed with isolation

pads. Equipment cabinets shall be leveled using the leveling feet unless design drawings specifically indicate to leave them on the casters.

BB. RACK BONDING. All equipment cabinets and racks shall be bonded to the telecommunication grounding system as indicated in specification section 270526

3.2 IDENTIFICATION AND TAGGING

A. General: Identification and tagging of SCS components shall be executed by the SCS installer. At a minimum identification and tagging shall be provided for the following components of the system:
   1. All horizontal and backbone cables at both ends of the cable in the cable jacket. Labels on each side shall be different indicating the location of the other side of the cable
   2. All faceplates indicating all jacks terminated in the faceplate.
   3. All patch panels.
   4. All racks
   5. All termination blocks
   6. All telecommunication rooms and outdoor enclosures.
   7. All intrabuilding backbone cables inside in ground pull boxes outside of the building shall have a visible label in each box they pass through.

B. The SCS installer shall follow the owner provided identification system. If owner does not have any preference or standard the SCS installer shall provide a system for approval of the A&E and the owner as indicated in the submittal paragraph of this specification. The identification system shall follow the TIA/EIA 606-C standard.

3.3 TESTING OF COPPER CABLING

A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA/EIA-568-C, Cabling Transmission Performance and Test Requirements.

B. For all 4-pair copper cabling terminated for the use of building systems or system provided under the contract, such as surveillance cameras, emergency phones, elevator phones, WAPs, Access control panels and building automation equipment, the required test shall be a Channel style test. This means copper test shall be done with patch cords that will be used for permanent installation of those devices.

C. For all 4-pair copper terminated for the use in work areas such as computers and phones, the test method selected for all 4-pair copper cabling is a permanent link style test. Permanent link test is defined as a test that does not include the patch cords to be used in the project.

D. General: In the event the A&E elects to be present during the tests, provide notification to the engineer two weeks prior to testing.

E. General: The installer’s RCDD shall sign off on all copper and fiber optic cable test results, indicating that he/she was in responsible charge of all cable testing procedures

and that all cables were tested in compliance with the contract documents and met or exceeded the requirements stated herein.

F. Testing Equipment: Tester shall be as manufactured by Agilent, Fluke, IDEAL or Wavetek. Tester shall be 100% Level IIIe compliant with ANSI/EIA/TIA 568C specifications for testing of the CAT6A cabling. No tester will be approved without meeting these requirements.

G. Each jack in each outlet shall be tested at a minimum to the manufacturer's performance of the cable to verify the integrity of all conductors and the correctness of the termination sequence. Testing shall be performed between work-areas and the equipment rack patch panel. Prior to testing UTP runs, the tester shall be calibrated per manufacturer guidelines. The correct cable NVP shall be entered into tester to assure proper length and attenuation readings.

H. Documentation of cable testing shall be required. The SCS installer shall provide the results of all cable tests in electronic format (final results in PDF format and raw data). Each test page shall be separated by standard page break (one test per page). The test results shall include: sweep tests, continuity, polarity checks, wire map, Attenuation, NEXT, PSNEXT, FEXT, PSFEXT, ELFEXT, PSELFEXT, ACR, Return Loss, Delay Skew, and the installed length. Cables not complying with the EIA/TIA 568C tests results shall be identified to the A&E for corrective action which may include replacement at no additional expense to the Owner. All identification names of the cables used in the test shall match the labeling system approved for the project and the corresponding shop drawings.

I. Any Fail, Fail*, Pass* or WARNING test result yields a Fail for the channel or permanent link under test. In order to achieve an overall Pass condition, the result for each individual test parameter must be passed. All test results shall come from a tester with the permanently enabled marginal reporting feature.

J. Test results shall show and comply with the margin claimed by the manufacturers over CAT6A permanent link specifications on all transmission parameters across the entire frequency range as shown on the manufacturer's cut sheets.

K. General: Copper multipair backbone cabling shall be tested for length, continuity, polarity checks and wire map. The SCS Installer shall provide the results of all Copper Riser cable tests in electronic format. The use of pigtails or special harness could be required to properly test these cables.

L. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.

M. All 4-pair patch cords shall be factory tested only.

3.4 TESTING OF FIBER OPTICS CABLING

A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA/EIA-568-C and the addendum for fiber optic testing.

B. General: In the event the Engineer elects to be present during the tests, provide notification to the engineer two (2) weeks prior to testing.

C. Cleanness: All fiber optics connector shall be cleaned properly before any testing and after testing. Proof of cleanness shall be required during the acceptance test for the SCS by the A&E. SCS installer shall have available during this test a 200X microscope or a video probe to demonstrate the cleanness of the randomly selected connectors by the A&E.

D. End to End Attenuation Test: The SCS installer shall perform end-to-end attenuation testing for each multimode fiber at 850 nm and 1300 nm from both directions for each terminated fiber span in accordance with EIA/TIA-526-14A (OFSTP 14) and single-mode fibers at 1310 nm and 1550 nm from both directions for each terminated fiber span in accordance with TIA/EIA-526-7 (OFSTP 7). A one jumper reference shall be used for all testing. For spans greater than 90 meters, each tested span must test to a value less than or equal to the value determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be < 2.0 dB. When calculating the link loss budget for spans greater than 90 meters use the values listed below. End to end attenuation shall be done with a Level II meter using a meter and light source equipment (also known as main and remote unit)

ATTENUATION DUE TO	FIBER TYPE	MAX. ATTENUATION
Terminating connectors. Field terminated options	All fiber types	0.75 dB per connector
Terminating connectors, pre-term fibers	All fiber types	No more than 0.2 dB additional to total dB loss measured at the factory in report sent by cable manufacturer.
Splices	All fiber types	0.3 dB per splice
Distance	OM1 (850nm/1300)	3.4 dB /1.0 dB per Km.
Distance	OM2, OM3 and OM4 (850nm/1300)	3.0 dB /1.0 dB per Km.
Distance	OS1 and OS2 (1310 nm/1383 nm/1550 nm)	0.65 dB /0.65 dB/ 0.5 dB per Km.

E. OTDR Test. Additional to end to end attenuation test, all fiber optic cables shall be tested with a Level III OTDR equipment for the following conditions:
1. Each known event (connector/splice) insertion loss at both windows for each fiber type (850/1300 nm for multimode and 1310/1550 nm for single mode). All events shall pass maximum allowed insertion loss for the event type as indicated in table above.
2. Reflective events (connections) shall not exceed:
   a. 0.75 dB in optical loss when bi-directionally averaged
   b. -35 dB Reflectance for multimode connections
   c. -40 dB reflectance for UPC single mode connections

d. -55 dB reflectance for APC single mode connections

3. Non-reflective events (splices) shall not exceed 0.3 dB.
4. Estimated distance for multiple strands of the same cable shall not vary more than 1% between strands.
5. Cable signature in the form of traces along the complete distance of the cable. Unexplained cable reflections shown in the OTDR shall require the installer to submit letter explaining such events and pictures of cable conditions in the locations where the unexplained events are located to demonstrate cable has not been kinked or damaged during installation.

F. OTDR Test conditions. All OTDR testing shall be performed with the following conditions:
1. Use a launch cable and a tail cable in accordance with fiber type being tested and requirements indicated by OTDR equipment manufacturer.
2. Launch and tail cables shall be products sold by testing equipment manufacturer and not field made cables.
3. Launch and tail cables shall be selected according to the type of connector being tested such as APC or UPC type connectors.
4. Use launch compensation mode during the test to subtract the effects of the launch and tail cables.
5. Test from one direction only, unless the presence of “gainers” are spotted during the test. In such case the installer shall test in both directions and adjust the test equipment to average measurements from both directions.
6. The SCS installer shall verify the backscatter coefficient use in the test to make sure it matches the coefficient of the cable being tested.

G. OTDR Testing Equipment used on this project shall have the specifications indicated in this following table:

SPECIFICATION	MULTIMODE	SINGLE MODE
Wavelengths	850 nm ±10 nm 1300 nm +35 / -15 nm.	1310 nm ±25 nm. 1550 nm ±30 nm.
Event Dead Zone. Measured at 1.5 dB below non-saturating reflection peak with the shortest pulse width. Reflection peak < -40 dB for mm and < -50 dB for sm.	850 nm: 0.5 [3.7] m typical 1300 nm: 0.7 [3.5] m typical	1310 nm: 0.6 [3.5] m typical 1550 nm: 0.6 [3.5] m typical
Attenuation Dead Zone. Measured at ± 0.5 dB deviation from backscatter with the shortest pulse width. Reflection peak < -40 dB for mm. and < -50 dB for sm.	850 nm: 2.2 [10] m typical 1300 nm: 4.5 [13] m typical	1310 nm: 3.6 [10] m typical 1550 nm: 3.7 [12] m typical
Pulse Widths (nominal)	850 nm: 3, 5, 20, 40, 200 ns. 1300 nm: 3, 5, 20, 40,	3, 10, 30, 100, 300, 1000, 3000, 10000, 20000 ns

	200, 1000 ns.	
Loss Threshold Setting	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments

H. The Test Report for each fiber strand shall include the following information:
1. Calculated Loss Budget for each optical fiber link (see attenuation table above)
2. Cable/strand ID matching shop drawings labeling system.
3. Name of technicians who performed the test.
4. Date and time the test was performed.
5. Measurement direction (from/to)
6. Jumper reference set up date/time and attenuation value
7. Equipment model and serial number used and calibration date.
8. End to End Attenuation Loss Data for each optical fiber link
9. OTDR Traces, one page per strand. Expand chart to cover most of the page
10. Each event loss data and test limits used, including test limit file date used.

I. For fiber optic cables with factory terminated connectors or pre-terminated pig-tails, The SCS installer shall provide also the test results performed at the factory for fiber optic cables with factory terminated connectors to compare with the field test done by the SCS installer. No significant variation between the factory test results and the field test results shall be encountered.

3.5 SYSTEMS WARRANTY AND SERVICE

A. SCS Installer shall follow all warranty and service requirements indicated in specification section 27 00 10.

B. Warranty: The SCS shall be required to be under the manufacturer's warranty program for a complete channel configuration including cable, jacks, patch cords and patch panels and include cabling specifically approved for the channel configuration with the manufacturer's components. Manufactures shall provide the warranty worst-case performance data for the installed cabling system, and the performance data indicated in the warranty documents/certificate.

C. A twenty five (25) year warranty available for the Structured Cabling System (Fiber optics and copper infrastructure) shall be provided for an end-to-end channel model installation which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement thereof.

D. Additional features of the warranty shall include:
1. That the SCS installed system complies with the margin claimed by the manufacturer above the category 6A channel specifications on all transmission parameters across the entire frequency range of 1-600 MHz as shown on the manufacturers catalogs and literature.

3.6 SPARE PARTS

A. As part of this contract the SCS installer shall provide the following spare parts.
   1. Ten (10) modular SCS jacks.
   2. Five (5) faceplates
   3. Two (2) faceplates with support post.
   4. Ten (10) fiber optic connector of each type used in the project.

B. As part of this contract the SCS installer shall provide the following tools:
   1. Two (2) modular SCS jacks termination tools when modular SCS jacks required a manufacturer specific tool.
   2. One (1) punch down tool with a 110 blade and one 66 blade.
   3. One electric (1) cable finder.

3.7 COMMISSIONING

A. SCS Installer shall follow all warranty and service requirements indicated in specification section 27 00 10.

3.8 ENGINEER'S FINAL ACCEPTANCE TEST

A. SCS Installer shall follow all requirements for final acceptance indicated in specification section 27 00 10.

B. The Engineer's final acceptance test will not include testing of structured cabling components, but could include verification of cleanness of fiber optic connectors.

3.9 TRAINING AND INSTRUCTION

A. Training shall only be done after all testing, identification process and commissioning have been completed and passed as indicated in this specification. Any training done prior to final acceptance will not be accounted for the formal training requested and the SCS installer shall re-do all training after the final acceptance test is passed, at no additional cost to the Owner.

B. SCS Installer shall follow all training requirements indicated in specification section 27 00 10.

C. The training for the SCS shall include the following topics:
   1. Detail explanation of the identification system.
   2. A walkthrough of all spaces and locations where terminations have been done in the project.

3.10 AS BUILT DOCUMENTS AND PROJECT CLOSE OUT

A. The SCS shall follow all requirements for as-build and close out documents indicated in specification section 27 00 10

B. The following are additional requirements supplementing the information provided in specification section 27 00 10:
   1. Provide the Warranty certificate issued by the manufacturer of the SCS infrastructure.
   2. The installer's RCDD shall affix his/her stamp to the as-built drawings, indicating that he/she has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed.
   3. As built drawings inside each telecom room. The SCS installer shall plot all as-built drawings and locate them inside each of the telecom rooms in the project. Each telecom room shall have the as-built drawings of the areas being served from that room. Each drawing shall be placed inside a clear vinyl document protector the size of the actual design drawing and affixed to a wall/plywood in the telecom room. The document protector shall be re-usable and shall allow the owner to replace the drawings as changes are done to the SCS infrastructure in the future. Without this information, substantial use of the system will not be provided to the installer.
   4. The SCS installer shall provide Excel software spreadsheet that defines the telecommunications outlet number, location, number of voice, data and special jacks. This database shall also provide the outlet patch panel connection to the riser/inter-floor cable, equipment, and telephone company demarcation circuit pairs as part of the as-built documentation.
   5. Electronic copies of all test results (copper and fiber). Electronic copies shall include raw data files and PDF files with results. PDF files shall be organized the following way:
      a. All copper cables for cables terminating in one telecom room in a single PDF files with the name equal to the label used in the shop drawings for the telecom room where the cables are terminated.
      b. All attenuation and OTDR test for all strands of a single cable shall be in one PDF file with the name corresponding to the Cable ID used in the shop drawings.

END OF SECTION 27 10 00

SECTION 27 11 01 – TELECOM RACEWAY SYSTEMS

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 telecom raceway systems.

1.3 RELATED WORK

A. Section 26 05 33 – Raceways and Boxes.

B. Section 26 05 36 – Cable Trays.

1.4 SYSTEM DESCRIPTION

A. Conduit, cable trays and boxes to form an empty raceway system.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Conduit: Refer to Section 26 05 33.

B. Cable trays: Refer to Section 26 05 36.

C. Outlet, pull or junction boxes: Refer to Section 26 05 33.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide pullboxes in telecom conduit runs spaced less than 100 feet apart, and on the backboard side of runs with more than two right angle bends.

B. Place telecom label on pull and junction boxes.

C. Provide pullwire in each telecom conduit run.

END OF SECTION 27 11 01

SECTION 27 41 00 - AUDIO/VISUAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: The General Requirements, Conditions of the Contract, these Specifications, Drawings, Addenda and Contract Modifications (the Contract Documents), and definitions of legal entity (such as Contract, Installer, Engineer, Owner, etc…) shall apply to the work of this specification section.

B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.

1.	27 00 10	Technology General Provisions
2.	27 05 28	Raceways for Technology
3.	27 10 00	Structured Cabling System
4.	27 05 26	Grounding and Bonding for Communication Systems

1.2 SCOPE OF WORK (SOW)

A. General: Refer to the requirements of the related documents identified in Part 1.1 of this specification, for scope of work requirements, which are supplemented by this section. This shall constitute the basis for the “Scope of Work” for this specification.

B. System: The goal of the project is to provide a finished, complete audiovisual system with the functionality, capacity, and operability, as described in the Contract Drawings and specifications herein. The finished, complete system shall serve as a vehicle for the transport of associated system signals from designated origination points to equipment interfaces and/or identified distribution points per the Contract Documents. The scope of work for the AVS installer shall include, but not limited to the following tasks:

1. Preparation of shop drawings, submittals, training and as-built information for the system.
2. Procurement, installation and warranty of all AVS hardware including projectors, flat panel displays, mounts for displays, signal transceivers, players, switchers, servers, etc.
3. Procurement, installation and warranty of all AVS cabling and wiring, including support system, and fire stopping for all low voltage cabling part of the AVS.
4. Programming labor of the AVS, including initial software set up, software registration, and initial data input, unless otherwise noted in this specification section.
5. Attend project plan meetings with the Owner and the Consulting Engineer (A&E) to fine tune data interchange details, network configuration and other user requirements:
6. Provide training and close out information as indicated in this specification.

C. It shall be understood by the AVS installers that this is an integrated system where multiple pieces of equipment from different manufacturers are required to be connected/interfaced together to make the AVS operational. To allow for competitive bidding multiple manufacturers are listed in the specifications for many devices and software, but it is the sole responsibility of the AVS installers to verify that their particular equipment and software selection integrate and work seamlessly with other equipment and software from the pool of approved manufacturers. These specifications represent a design guideline and design intent but they are not intended to verify that all possible equipment and software listed in this specification work and integrate seamlessly with any equipment and software form the pool of acceptable manufacturers. Approval of submittals for the AVS by the A&E of the project does not relieve the responsibility for the AVS installers to deliver a working system. Any equipment changes required because of incompatibility between different devices of a particular system, even after the equipment has been approved by the A&E, shall be provided at no additional cost to the owner.

D. The following items are not part of this scope of work:
   1. CATV tuners
   2. Items noted on drawings as being Owner Furnished Equipment (OFE).

E. The following is a list of rooms where Audio Visual system shall be provided:
   1. See Drawings.

F. Consumables: The Audio Visual System (AVS) Installer shall provide as part of the scope the following consumable devices:
   1. One (1) wind screen for each microphone in the project.

G. Spare parts: The AVS Installer shall provide as part of the scope the following spare parts:
   1. None.

H. Test equipment: The AVS Installer shall provide as part of the scope the following test equipment:
   1. None.

1.3 INSTALLER QUALIFICATIONS

A. General: The qualifications and requirements herein apply to the specific technology identified by this specification section. Refer to the specification sections identified in Part 1.1 “Related Documents”, of this specification, for additional requirements, which are supplemented by this section.

B. Installer Qualifications: The Installer directly responsible for the work described in this specification section is also referenced as the AVS Installer. The Installer shall be a licensed and registered contractor who is, and who has been, regularly engaged in providing the installation of audiovisual systems of similar size and complexity for at least the immediate past five (5)-years.

C. Project manager requirements: The project manager for each company participating in the installation of the AVS shall be a Certified Technology Specialist (CTS) by Avixa. Proof of current certification shall be provided with the submittal

D. Programmer-Installer: The AVS Installer must have a factory-trained programmer/installer, for the provided Project products, in full-time employment, as part of their staff. The AVS installer needs to provide certificates of completion of training for the staff that will be taking part in the execution of this project

E. Qualification Documentation: The Installer shall provide the following documentation with their bid package, as evidence that the requirements for the Installer qualifications have been satisfied:
   1. A list of not less than five (5) references for jobs of similar size and complexity including:
      a. Project Names
      b. Locations
      c. Contact Names
      d. Contact Telephone Numbers
   2. Location (specific street address) of the office from which this installation and warranty work will be performed. It is preferred that the Installer has established and maintains a permanent office within 150 miles of the project site.
   3. Copies of Manufacturer certification certificates. It is required that the Installer possess the following certifications, at a minimum:
      a. Crestron systems certified dealer, installer and programmer.
      b. AMX certified dealer, installer and programmer.
      c. Extron certified dealer, installer and programmer
      d. List all that apply
   4. Copies of Licensure certificates.
   5. Copies of Insurance and Bonding certificates.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: See details for alternates and substitution in specification section 27 00 10.

B. Specific equipment: When the design drawings indicate a brand and a model number for a piece of equipment as part of the audio visual system, the AVS Installer needs to provide the same device as indicated. Substitutions for this type of equipment are not acceptable.

C. Non-specific equipment: When the design drawings do not indicate a brand and a model number for a piece of equipment as part of the audio visual system, the AVS installer is free to pick equipment that meets the minimum specifications indicated in this section. The AVS installer needs to submit the selected choice as part of the submittal process

1.5 SHOP DRAWINGS AND SUBMITTALS

A. The AVS installer shall follow all requirements for shop drawings indicated in specification section 27 00 10.

B. Project Start Submittals: A maximum of 60 days after the AVS installer receives a notice to proceed with the project, but no sooner than a year before substantial completion, the following information shall be submitted.
   1. Cut sheets with all specifications of every device, cables and connectors to be used in the project.
   2. One-line diagrams with all devices included in the systems. Each system in a different sheet.
   3. User interface and faceplate color submittal. The AVS installer shall prepare a separate submittal with the shape and color of all user interface plates to be approved by the Architect of the project or the Owner.
   4. Rack elevations of all AV equipment for all rooms in the project.
   5. Conduit rough-in requirements of all wall and ceiling mounted devices for all equipment part of the AVS system.
   6. Any installation and rigging details for loudspeaker systems or other heavy equipment part of the AV system.

C. Construction Submittals: During the construction process the AVS installer shall submit various documents for approval prior to continuing with the installation process. Here is some of the information the AVS installer needs to submit:
   1. Before starting the programming process the AVS Installer shall provide the following information:
      a. A schematic presentation of the layout of all the user interfaces in the project. The AVS Installer needs to get approval of this submittal before starting any programming. These layouts shall include all graphics with all button sizes, shapes, colors and wording to be used in all user interfaces.
      b. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
      c. A layout/presentation of any digital audio programming and user interfaces that are part of the project.
      d. Detailed layout of the DSP filters to be used in each DSP processor.
   2. Any design changes whether originated by the Owner, Designer or by the AVS Installer as a VE suggestion need to follow the same submittal process described in the previous paragraph for all equipment involved on the change.

1.6 PROJECT SPECIFIC SOURCE CODE OWNERSHIP

A. Definition of project specific source code: Project specific source code includes all source code created to generate an executable file to be intended to run in any equipment used in the installation of the AVS. Examples of project specific source code include source code used to generate executable files for control processors, DSP processors and touch panels. Project specific source code does not include source code used to create programming tools and compilers or source code used to generate operating systems or application programs running in PC based workstations.

B. Ownership: Any project specific source code used in this project shall remain the exclusive property of the Owner. By accepting the contract to perform the work included in this project, the AVS installer or designer and any other companies working creating project specific code during this project relinquish the right of ownership of this source code, and waive any licensing fees or royalties for the use of source code by the Owner or any company authorized by the owner to perform changes in the source code after the project is substantially completed for an undefined period of time.

PART 2 - PRODUCTS

2.1 SYSTEM FUNCTIONS

A. System Signals for All Systems
1. General: The completed system shall be capable of receiving, processing, routing and distributing the associated signals, noted herein, from and to the respective devices identified under Part 2 of this specification and the Contract Documents.
2. The system shall provide an audio signal response of ±6dB un-equalized (±3dB equalized) from 65Hz to 18KHz, throughout.
3. Digital video signals through the system shall be capable of delivering Up to 4096x2160@60Hz (DCI 4K60); 4:4:4 color sampling; HDR10, HDR10+, Dolby Vision, and Deep Color support.
4. Control signals through the system shall be maintained to the minimum level established by the control equipment manufacturer for the control protocol utilized. This level shall be correct at all connection points in the system.

B. Remote Asset Management Software
1. General: The Remote Asset Management Software (RAMS) is another tool that will be provided to the owner to control the AVS system. When referenced in this section within the room functionality, the RAMS shall be able to provide the functionality described in these paragraphs.
2. Capabilities of the RAMS. This software tool shall have the following features:
   a. Connect to all controllable rooms in the project through the owner's IP network.
   b. Fully compatible with the controllers installed in each room part of the AVS.
   c. Be able to support all the controllable rooms in this project plus 10% expansion capacity.
   d. Be able to have at least two (2) simultaneous users on the system.
   e. A customizable graphical user interface.
   f. Unlimited Grouping features.
   g. Real-time monitoring, control and diagnostics of control systems in each room on the project.
   h. Built-in event scheduler.
   i. E-mail alerts.
   j. Built-in logging, report and chart generation.
   k. SSL Authentication
3. Computer system. The AVS Installer shall provide and install a computer system capable of running the RAMS as required by the manufacturer of the software

package. The AVS Installer shall install the RAMS in an owner provided computer system.

4. Software customization: The AVS Installer shall customize the user interface of the RAMS according to the owner's request. The AVS installer shall meet with the Owner and Design engineer during the construction process and agree on the features that will be used by the owner from this tool. Once this step is done, the AVS Installer shall program the RAMS interface based on the conclusions of that meeting. At a minimum all AVS with control processors shall have the following monitoring features through the RAMS:
    a. All media players and recorders usage: start time, stop time and cumulative use.
    b. All sources connected to interface plate usage: start time, stop time and cumulative use.
    c. Projector usage hours.
    d. Flat panel display usage hours.
    e. UPS monitoring, including automatic start, battery test and status, and internal temperature.
5. Database input: The AVS Installer shall fill the RAMS database with the correct information of all the rooms that have controllable AV equipment in the project.
6. At a minimum the following alarms of the AVS shall be monitored by using the RAMS:
    a. Projector in video mute for more than 1 hour.
    b. Projector turned off (not on stand-by).
    c. Projector approaching 85% of estimated life time.
    d. Projector bad (if reported by projector)
7. Reporting capabilities: The AVS Installer shall provide at least five (5) different reports from the RAMS. The AVS installer shall meet with the Owner and Design engineer during the construction process and agree on the fields of each report that will used by the owner from this tool. Once this step is done, the AVS Installer shall program the RAMS reporting features to accomplish the conclusions of that meeting.
8. Training: The AVS installer shall provide two levels of training for the RAMS. Administration level training shall be provided for at least 4 hours. User level training shall be provided for 2 hours.
9. Design selection: Crestron Fusion

C. Computer Based User Interface
    1. General: The computer based user interface (CBUI) is another way for the Owner to control the AVS. This interface is in the form of a computer software program with the following requirements:
        a. Needs to be an executable file capable of running in any Windows based PC.
        b. One file per controllable room is required.
        c. Needs to have the same user functions available inside the room in touch screens and keypads.
        d. The "look" and layout of the interface shall be the same as the one in the room.
        e. Programs shall be password protected and have SSL.

2. Delivery: The AVS Installer shall provide two (2) DVD disks with all the programs in executable and source code format inside. Each file shall be properly labeled with the room description and the room number.

D. Owner Provided Input Sources and Destination Devices
1. General: Design drawings could indicate AV equipment, part of the AVS, to be provided by owner (as OFE or owner furnished) or third parties. Such equipment is explicitly indicated as such in design drawings to distinguish it from all other equipment to be provided by the AVS installer. When such equipment is indicated in the drawings the AVS Installer shall interface with it. Refer to the design drawings for audio, video and control lines required for owner provided equipment.
2. Scope of work: It is in the scope of work of the AVS Installer to run, terminate and connect the audio, video and control lines to owner provided devices as shown in the design drawings. When control lines are indicated in the design drawings, the AVS installer shall program all control features described in each system functions per controllable room, including all features related to owner provided equipment or third party equipment.

2.2 SYSTEMS NARRATIVE

A. The intent of the system is that an AV-over-IP streaming solution be implemented using AVS provided switches. Basis of design is Crestron. AVS to provide all equipment required for a turnkey system including but not limited to Crestron Hardware, Network Switches, and Cabling. See drawings for individual room riser diagrams and narratives

2.3 WIRE, CABLE, CONNECTORS, AND ACCESSORIES

A. General: The AVS Installer shall provide the system components and materials necessary to properly install, support, and terminate all audiovisual cabling, in accordance with the related documents identified in Part 1.1 of this specification. Where the Project Electrical Installer has provided a raceway designated for use by this system, the AVS Installer shall coordinate and install all required cables into the provided raceway. The AVS Installer shall also provide and attach all required cable connectors.

B. Cable: The AVS Installer shall provide all cabling associated with, and required to, provide a complete, operable system in accordance with the Contract Documents. All cable provided by the AVS Installer shall be of a manufacture and quality consistent with the design intent, and shall be reviewed by the Engineer prior to installation.

C. Cabling in air handling spaces. The AVS Installer is responsible for determining the rating of the cables to be used for the AVS, as per current version of the National Electrical Code. If, at the bidding point the AVS Installer is not certain about the type of cables to be used in the project, the AVS Installer shall assume that all cables need to be plenum rated cables.

D. Cabling below grade: When cable part of the AVS have to be run in conduits below slab and grade level, the AVS Installer shall use only cables with water-blocking jackets.

E. Cable signals: The following is a list of signal types and the cables to be used for those signals:
   1. Line level audio signal cable: Provide one (1) twisted pair cable for mono signals and two (2) twisted pair cables for stereo signals. Twisted pair cables to be 22 AWG stranded (7X30) tinned copper conductors with overall foil shield (100% coverage), with 22 AWG stranded tinned copper drain wire.
   2. Microphone level audio signal cable: Provide one (1) twisted pair cable, 20 AWG stranded (7X28) tinned copper conductors, overall foil shield (100% coverage) with a 20 AWG stranded tinned copper drain wire.
   3. Analog video, audio and control over twisted pair cable: Provide one (1) 4-pair 24 AWG twisted pairs solid bare copper conductors with polyolefin insulation. If equipment manufacturer supports the use of standard UTP Category 6 for this application, the AVS installers shall provide cables in compliance with specification section 271000 and all cables part of the AVS shall be included in the same warranty as all cables provided under specification section 271000. If equipment manufacturer recommends the use of low skew cables, only low skew cables shall be used.
   4. Proprietary Control cable (i.e. Cresnet® Signal): Provide one (1) cable with 1 twisted pair 22 AWG stranded bare copper conductors with overall aluminum/polyester foil (100% coverage) and a 24 AWG tinned copper drain wire, and one (1) unshielded twisted pair, 18 AWG stranded bare copper conductors.
   5. Control cable (i.e. RS-232, RS-485 Signal): Provide one (1) cable with 1 or 2 twisted pair 22 AWG stranded bare copper conductors with overall aluminum/polyester foil (100% coverage) and a 24 AWG tinned copper drain wire. Pair count depends on manufacturer's specifications.
   6. Digital video, audio and control over twisted pair. Provide one, two or more cables cat 6 UTP as required by transceiver equipment manufacturer to ensure the digital signal is transported properly up to 328 ft, at maximum resolution indicated in part 2.01 of this specification. If equipment manufacturer supports the use of standard UTP Category (5e, 6 or 6A) for this application, the AVS installers shall provide cables in compliance with specification section 271000 and all cables part of the AVS shall be included in the same warranty as all cables provided under specification section 271000. If equipment manufacturer requires the use of proprietary cables, only these cables shall be used in the project. The color jacket for these cables shall be different from voice/data cables. AVS installer to coordinate color jackets with structured cabling installer.
   7. UTP Category cables. Provide UTP category cables for all Ethernet connection part of the AVS as indicated in design drawings, including horizontal cables, patch cords and station cables. All cables part of the AVS shall have all specifications and shall be included in the same warranty as all cables provided under specification section 27100. The color jacket for these cables shall be different from voice/data cables. AVS installer to coordinate color jackets with structured cabling installer.
   8. Speaker Cable: Provide two (2) unshielded bare high conductivity ETP copper 16 AWG stranded conductors, with overall jacket.

9. RGBHV Video cable: Provide five (5) coaxial 25 AWG solid .018” tinned copper conductors, FPFA insulation, Duobond® foil plus a tinned copper interlocked serve shield (100% coverage). Cable shall have inner jacket on each coaxial conductor, outer jacket for all conductors and characteristic impedance of 75Ω on each conductor.
10. IR control signal cable. Provide one (1) pair, unshielded twisted pair cable with 22 AWG solid copper conductors.
11. Contact closure signal cable. Provide one (1) or more unshielded twisted pair cable with 22 AWG solid conductors. Quantity of pairs as required by the application.
12. HDMI Cables. All HDMI cables longer than 10 meters (32.8 ft.) must include an adaptive cable equalizer capable of providing not less than +40 dB of cable compensation @ 825 MHz. Such device must be capable of operating automatically without the need for human intervention and must include an external AC to DC power converter that can accept 100-240VAC @ 50/60 Hz. Furthermore, such device must also include I2C correction circuitry to mitigate the effects of long cable runs on the DDC clock and DDC data signals. HDMI cables shall have the following requirements:
    a. Support HDMI v2.1 with resolutions up to 8K60 and 4K120 with 12-bit color depth
    b. Support HDMI v2.1 Category 2 data rates (3.4 Gbit/sec.) lengths up to 7.5 meters
    c. Support HDMI v2.1 data rates up to 2.25 Gbit/sec. lengths up to 40 meters
    d. Support PC data rates up to 1.65 Gbit/sec. lengths up to 60 meters
    e. Supports PC resolutions up to 1600x1200 / 60 Hz and 1920x1200 / 60 Hz
    f. Made of AWG-22 gauge wires
    g. Triple shield for noise immunity
    h. Cable jacket shall have dual UL Ratings: UL13 (CL2) and UL758 (AWM20276) for non-plenum spaces. In plenum environments cables shall have a CL2P rating or CMP rating.
    i. RoHS compliant.
    j. Gold plated connectors
13. DVI Cables. All cables carrying DVI signals through conduit, floor slabs or longer than 10 ft. shall be HDMI cables as described in previous section with HDMI to DVI adapters in both ends.

F. Connectors and plates: The AVS installer shall provide connector and plates to terminate all wiring part of the AVS, regardless if shown or not in the design drawings. As a general guideline the AVS Installer shall follow these recommendations:
1. Only use crimp type BNC connectors on coaxial baseband video cables. Use crimp type F connectors on RF based coaxial cables. Use only connectors with the same impedance as the cable where they will be terminated.
2. When custom panels or plates are required in the project, the AVS Installer shall submit detail drawings of all plates for approval by the Design Engineer.
3. Whether shown in the design drawings or not all cables coming out of an outlet box into an equipment shall have a disconnect means at the outlet box with a face plate. Faceplates with grommets are not acceptable as pass-through connections to equipment.
4. All termination of UTP Category (5e, 6 or 6A) cables shall be done in accordance to specification section 27 10 00.

2.4 DEDICATED COMPUTERS FOR AV SYSTEMS

2.5 PROJECTOR (Medium to Large Conference Space)

A. General: The projector referenced in this specification section and in the design drawings for used in medium to large conference spaces shall have the following specifications:
   1. Projector native image format: 16:10,
   2. Light source technology: Laser,
   3. Projector technology: LCD
   4. Brightness: minimum 6000 ANSI Lumens
   5. Native resolution: 1920 X 1200
   6. Contrast ratio: minimum 900:1
   7. Estimated laser life: minimum 20,000 Hours. Extended light source mode must be available to extend life to up to minimum 30,000 hours.
   8. Lens: Manual zoom and focus
   9. Lens throw distance: as indicated in the drawings
   10. Usable resolutions: The unit shall be capable of displaying in both 1080P (1920x1080 pixels) and WUXGA (1920x1200 pixels)
   11. Video input ports: (2) HDMI HDCP compliant, (1) HDbaseT
   12. Audio input ports: (2) unbalanced stereo inputs
   13. Audio output ports: One (1) unbalanced stereo variable output,
   14. Control ports: RS-232 in a DB9 connector, LAN port, Wireless LAN (must be disabled unless noted on plans)
   15. Warranty: 3 years, commercial grade unit. Consumer grade units with extended warranties not acceptable.

B. Accessories: This projector shall be supplied with a corresponding lens to achieve the throw distance indicated in the design drawings. Projector mounts shall be provided with all projector. Design selection for the projector mount is Chief Manufacturing Company recommended mount for the projector specified.

C. Basis of Design: Epson L615U/L610U

D. Approved Equals:
   1. Christie Digital,
   2. Panasonic,
   3. Sharp,
   4. Hitachi,
   5. NEC,
   6. Mitsubishi,
   7. Barco,
   8. Projection Design,
   9. Digital Projection,
   10. Optoma.

2.6 ELECTRIC SCREENS

A. General: The Electric screen referenced in this specification section and in the design drawings shall have the following specifications:
   1. Screen format: 16:10
   2. Screen dimensions: As shown in the design drawings ± 3 inchs
   3. Screen projection type: Front projection
   4. Screen case mounting: in-ceiling
   5. Tensioned screen: Yes
   6. Screen gain: 1 or greater
   7. Viewing angle: 45°
   8. Screen fabric: seamless, flame retardant, mildew resistant vinyl.
   9. Motor: oil free, quick reversal, with adjustable limit switches.

B. Basis of Design: Draper Access V series displays

C. Accepted manufacturers:
   1. Da-Lite,
   2. Draper,
   3. Stewart.

2.7 NETWORKING EQUIPMENT

A. General: All networking equipment required for the AVS shall be provided in the scope of work of the system and it shall be in accordance this specification.

B. Network Switch:
   1. Network switch Requirements:
      a. 1-Gigabit port for every connected DM NVX endpoint
      b. Nonblocking backplane
      c. Layer 3
      d. IGMPv2 implementation
      e. Switch make and model shall match owner’s standard for ease of management. If owner utilizes any network control software, such as Cisco DNA, switches installed shall be capable of running this software and all appropriate licenses shall be turned over to the owner at end of project.
   2. Network Switch Configurations
      a. IGMPv2 snooping enabled
      b. IGMPv2 querier enabled
      c. Fast-leave enabled (also known as immediate-leave)
      d. Inter-switch uplinks (if required): The uplinks must have sufficient bandwidth for all encoders and decoders connected to the network switch.
      e. Allocate 1 Gigabit per encoder or decoder connected to the switch. - Uplinks must be configured properly to support multicast traffic
   3. Network Configuration
      a. Configuration must support AES67 multicast audio streams
      b. Network must have DNS, DHCP, Active Directory & RADIUS services. Coordinate with IT to provide these items.
      c. Owner shall receive configuration files for all switches installed by AVS.

4. Network Topology
    a. AV network shall be largely standalone with AV network switches linked using fiber uplinks. Fiber uplinks shall be patched through the MDF. Fiber may be specified on drawings, however if not specified it is the responsibility of the AVS to design, submit for review, and install fiber per specification sections listed in Section 1.1.
    b. It is anticipated a link to the owner's network will be required to support wireless tablets, x-panel technology, and maintenance. Coordinate protocols required. All other traffic through this port shall be restricted unless otherwise requested by owner. This link shall be done through the control processor with the normal LAN port connected to the owner's network and the Control Subnet port connected to AV switches.

2.8 CABLE BOX (CABLE RECEIVER)

A. General: Cable boxes also referenced as cable receivers will be owner provided.

2.9 IDENTIFICATION AND LABELING TAGS

A. The AVS installer shall follow labeling materials indicated in specification section 27 00 10.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. General: The AVS installer shall follow all installation practices indicated in specification section 27 00 10.

B. Workmanship: The AVS Installer shall adhere to, at a minimum, the following installation practices:
    1. Securely mount equipment plumb and square in place. Where equipment is installed in cabinets, provide mounting bolts in all equipment rack fastening holes. All rack mount equipment shall be secured with Rackmount Solutions HTX™ security screws (STAR-TYPE or similar) provided with nylon washers between bolt heads and equipment.
    2. Where equipment (such as VHS players, monitors, DA's etc… and other system devices) is packaged by the manufacturer without rack mount ears or braces, as part of a regular manufacture process, the Installer shall provide all required, accessory ears, brackets, and shelves, which are necessary to properly mount the equipment within the designated cabinets and rack locations.
    3. Provide appropriate ventilation panels, vents, and/or fans to assure sufficient ventilation for adequate cooling of all equipment.
    4. Confirm the polarity and phasing of system components before installation. Connect to maintain uniform polarity and phasing.

5. Insulate all non-insulated, stranded conductors before making termination when connecting to equipment terminals.
6. “Wire”, “wing” and “twist” NUT type connections are not permissible for any type of signal connection.
7. All wiring is to be free from grounds loops, shorts, opens, and reversals.
8. Neatly tie all cabling within equipment cabinets, housings, and terminal cabinets with nylon cable ties at not more than 12" intervals for cables different from 4-pair CAT cables. Use Velcro straps to tying all 4-pair CAT cables. Install in accordance with the latest EIA installation standards. Engineer approved wiring trough may be used in lieu of tie-wraps. Cable routing shall not braid or cross with other wires in parallel more than once.
9. Secure all cables in equipment cabinets and terminal cabinets to provide strain relief at all raceway exits in accordance with NFPA 70 including all supplements. All plugs and receptacles are to be the grounding type.
10. Connect all equipment power to surge/noise suppression outlet strips or associated power conditioning devices.
11. Where system cables are extended through an exposed umbilical connection, the Installer shall harness all associated cable within a common, manufactured, flexible, sheath (ex. Snakeskin™).
12. All racks and cabinets shall be bonded to a grounding system as required by NEC.

C. Raceways. All raceways for audio/visual devices shall have the following specifications:
1. Refer to specification section 27 05 28 for all raceways specification.
2. All cables for speaker level signals, regardless of their level shall be run in separate raceways from other low voltage cables.
3. All cables for microphone level signals, regardless of their level shall be run in separate raceways from other low voltage cables.
4. Separation of Raceways: Cable tray supports can be used as supports for hangers for AVS distribution cables.
5. Raceways for AV outlets: Outlets for AV cables shall be composed of electrical boxes (sized for the amount of connectors) and a conduit(s) to the nearest accessible ceiling space. All AV outlet boxes shall be at least 2.5” deep.
6. All indoor rated cables can be supported with j-hooks or cable hangers above accessible ceiling spaces. J-hooks shall be spaced no longer than 4. Ft.

D. Labeling System. The labeling system for all cables shall be a system that allows for unique identifiers for each cable. Each cable has to have an indicator from where it is coming from and an indicator to where it is going to.

E. Engraving: All push buttons interfaces and connection plates part of the AVS shall be engraved with descriptive wording of the use of the button/plate. The AVS Installer shall submit and receive approval for the proposed wording in each button/plate before doing the engraving. Failure to follow this step might cause the AVS installer to replace the buttons in interfaces and/or plates where the Owner is not satisfied with the wording of the label at no additional cost to the Owner. The color of the wording in the engraving shall have high contrast with the background color of the button.

F. Installation of Screens: Whether shown in the drawings or not the AVS installer shall install all projection screens following the following installation practices:
   1. All electric screens shall be provided with a low voltage controller to be mounted inside the screen housing.
   2. All electric screens shall be provided with a control wall plate mounted at 48" A.F.F.
   3. All in-ceiling screens shall be leveled with the ceiling grid.
   4. All in-ceiling screens housing shall be plenum rated when installed in plenum spaces.
   5. All in-ceiling screens installed in hard ceilings shall include an access panel no smaller than 16"X16" to access the electrical junction box of the screen. Access panel shall be a metal panel, with a hinged door and painted the same color as the finished ceiling.
   6. Low voltage switch for manual control of screen shall be installed adjacent to screen or adjacent to wall mounted touch screen if provided.

G. Projector Installation: The Installer shall adhere to, at a minimum, the following installation practices for projectors:
   1. Projector shall be provided with corresponding mounting brackets depending on the projector selected.
   2. All anchors and supports whether pre-fabricated or customs, required to mount the projector where indicated in the design drawings are in the scope of work of the AVS Installer
   3. When electronics are provided next to the projector (receivers, controllers, etc.), provide an enclosure to mount all electronics suitable for the space above the ceiling (plenum, nor plenum)

H. Flat Panel Display Installation: The AVS Installer shall adhere to, at a minimum, the following installation practices for flat panel display devices
   1. All anchors and supports whether pre-fabricated or customs, required to mount the displays where indicated in the design drawings are in the scope of work of the AVS installers.
   2. All walls where flat panel displays will be installed shall be re-enforced with sheet metal behind the drywall. The extent of the re-enforcing shall be the contour of the flat panel display to be installed.
   3. When flat panel displays are installed inside a wall niche, the AVS shall provide a wall mount with adjustable depth that allows the flat panel display to be installed flush with the exterior wall.
   4. For flat panel displays mounted on structures, the installer shall provide anchoring as approved by structure manufacturer.
   5. For flat panel displays suspended from the structure above, the installer of this system shall provide all custom brackets and pipes properly secured to the structure to mount the displays

I. Speaker Installation: The Installer shall adhere to, at a minimum, the following installation practices for speakers:
   1. All ceiling mounted speaker shall have a support wire tie to the building structure. Ceiling speakers shall not be supported from the ceiling grid.

2. All ceiling mounted speakers shall be installed with a backbox to prevent sound from dispersing into the plenum space and causing noise issues in adjacent rooms.
3. When ceiling speakers are mounted in fire rated partitions, the speakers shall have UL listed speaker back boxes with a fire rating no less than the rating of the partition.
4. All in-wall speakers shall be installed with pre-construction brackets.

J. Equipment Rigging: When speaker assemblies or arrays weight more than 100 lbs, the AVS installers shall follow all rigging instructions from the manufacturer and shall be done by an experienced rigger. The AVS installers shall also adhere to the following practices:
1. Only the rigging equipment and method listed by the manufacturer of the equipment are approved for the installation No substitutions are accepted.
2. Only the rigging points available in the speaker assembly are accepted as means of support.
3. All anchors and supports whether pre-fabricated or customs, required to mount the displays where indicated in the design drawings are in the scope of work of the AVS installers.
4. Shop drawings for rigging methods shall be signed and sealed by a licensed structural engineer.

K. Millwork Openings: When AV equipment like flip tops and plates will be mounted in millwork provided by the owner or third parties, the AVS installers shall provide cut out dimensions for all the AVS equipment listing location in the millwork where the cuttings need to be done. It is the AVS installer's responsibility to install those devices in the millwork, once the openings have been done. All millwork opening shall be coordinated through general contractor to install table boxes..

L. Floor Boxes. Floor boxes used for connection to teaching lecterns, podiums, conference tables, or mixing borads shall have at least the following minimum requirements:
1. Floor boxes shall be large enough to have at least 3 different compartments, one for power one for voice/data cables and one for AV.
2. Each low voltage compartment shall have a separate raceway back to the accessible ceiling space. If speaker wires are run from the lectern, the AV compartment shall have one 1" and one ¾" conduit to the nearest accessible ceiling space. If no speaker wires are run from the lectern, at least one 1" conduit from the AV compartment to the accessible ceiling shall be provided. Additional conduits might be required depending on the application.
3. There shall be no daisy-chaining of AV conduits between adjacent floor boxes. Floor boxes shall also allow to recess the connectors from the umbilical cord tied to the lectern.
4. Floor boxes shall have a recessed compartment to hold connectors. Floor boxes that leave AV connectors flushed with the floor are not desirable since they become tripping hazards and could be easy broken with the lectern when moved.
5. AV compartments shall have termination plates and connectors for all cables coming from the accessible ceiling space. Pass-through cables shall not be allowed in floor boxes. All connectors shall be properly secured to the plates in the floor box. All unused compartments shall have blank plates.

M. Structured Cabling Infrastructure: The AVS Installer shall adhere to specification section 27 10 00 for all requirements of structured cabling components to be used as part of the AV system. The structured cabling components include but are not limited to:
   1. All unshielded twisted pair Category cables and fiber optic cables
   2. Termination devices like termination jacks, patch panels and faceplates.
   3. All UTP and fiber optics patch cords.
   4. All testing procedures for Category and fiber optic cables.

3.2 REQUEST OF IP ADDRESS

A. General: The AVS installer shall follow all requirements indicated in specification section 27 00 10 for the request of IP addresses for devices part of the AVS.

3.3 SOFTWARE PROGRAMMING AND INSTALLER TESTING

A. The software programming and testing of the AVS system will be a multi-step process. The AVS Installer shall provision in the proposal for the time indicated in each of the steps:

B. Briefing Step: A maximum of 45 days after the AVS installer receives the NTP for this project, the AVS installer shall request one or more briefing sessions with the Owner and/or design engineer to go over the expectation of each room and clarify any points that might not be clear to the AVS Installer. Some important notes about this step are:
   1. The AVS installer shall allocate at least 8 hours of meeting time
   2. Travel time will not be counted as part of the meeting time.
   3. The quantity of staff required to attend these meetings by the AVS Installer is sole decision of the AVS Installer.
   4. Before the start of this step the AVS installer shall have software programming submittals approved as described in part 1 of this specification section.
   5. The AVS Installer shall prepare meeting minutes of the key decisions made during these meetings. The approval of these meeting minutes by the Owner and Design Engineer will be accepted as approval notice of this step.

C. Shop Programming Step: Once the briefing step has been completed and approved, the AVS installer shall allocate off-site programming time to accomplish all the requirements listed in this specification and the clarifications done in the previous step. It is the sole responsibility of the AVS Installer to estimate how many man hours are required for this step. This step does not require approval by the Owner and/or design Engineer.

D. Field Verification Step: After all AVS equipment has been installed on site and the system has been programmed, the AVS Installer shall request one or more working sessions with the Owner and/or design engineer to verify in the field the functionality of the AVS system. Some important notes about this step are:
   1. The AVS Installer shall allocate at least 10 hours of working sessions.
   2. Travel time will not be counted as part of the working sessions.

3. The AVS installer shall have different AV media and sources to test all features in the AVS system.
4. The quantity of staff required to attend these meetings by the AVS Installer is sole decision of the AVS Installer.
5. Physical installation of all devices will be checked by the Owner and/or the Design Engineer. Any deviations in the installation of the equipment part of the AVS from this specifications and previous meetings will be noted by the Design Engineer in a “punch list”. This punch list will be send to the AVS installer within the next 5 days of the meeting for immediate corrective action. One punch list will be prepared for each room with AVS.
6. The AVS Installer shall prepare meeting minutes of the key decisions made during these meetings that affect the programming sequence. The approval of these meeting minutes by the Owner and Design Engineer will be accepted as approval notice of this step.

E. Final Adjustment Step: Once the previous step has been approved, the AVS Installer shall allocate time to make any corrections to the AVS system on site based on the conclusions of the previous step. It is the sole responsibility of the AVS Installer to estimate how many man hours are required for this step. This step does not require approval by the Owner and/or design Engineer.

F. Data Wiring and Fiber Optic Testing: Testing of UTP data wiring, copper patch cords, fiber optic cables and fiber optic patch cords shall be done as indicated in specification section 27 10 00. Testing results shall be submitted as indicated in the same specification section.

G. Signal Adjustment: The AVS Installer shall ensure that the following adjustments, tests and measurements, at a minimum, have been completed:
1. The system shall be measured and adjusted for optimum signal quality and minimum signal loss, to all audio and video signals, through the system channel, using appropriate test equipment and standardized testing procedures.
2. The system shall be measured and adjusted for optimum signal-to-noise ratio and maximum headroom in the system electronics.
3. The system shall be measured and adjusted to eliminate distortions or degradation of signal resulting from, but not limited to, clipping, hum, noise, and RFI interference.
4. The Installer shall check the quality of each signal, at its source, and compare it against the quality of the signal at various points of its transmission through the system. The Installer shall correct the system for any significant (the lesser of 2dB or the manufacturers throughput requirements) signal distortion or loss.

3.4 SYSTEM WARRANTY AND SERVICE

A. General: The AVS installer shall follow all warranty and service requirements indicated in specification section 27 00 10.

3.5 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The AVS installer shall follow all test requirements indicated in specification section 27 00 10.

B. As part of the Engineer's final acceptance all sources, inputs, outputs and interfaces will be tested. Additional notes about the final acceptance test:
   1. It is the sole responsibility of the AVS system installer to estimate the time allocated for this step. It is assume that at this point in time all the features of the AVS system are clear to the Owner and the AVS Installer so this step is just to make sure that all the features are working properly as agreed.
   2. The AVS installer shall have different AV media and input signal generators to test all input plates and sources in the AVS system.
   3. The quantity of staff required to attend these meetings by the AVS Installer is sole decision of the AVS Installer.
   4. Failure to complete one or more of the previously issued punch list items or failure to correct any programming changes previously noted will revoke acceptance of the room or system being tested.
   5. Final acceptance will be granted on a room by room basis.

3.6 TEST EQUIPMENT REQUIRED.

A. Test Equipment: The AVS Installer shall supply all testing instruments required for the equipment programming and system tests. The AVS Installer shall use test equipment meeting the minimum specifications, identified herein, to perform system calibrations and adjustments. The AVS Installer shall make available the same test equipment available, for inspection by the Engineer, during Final Acceptance step.
   1. Direct reading Audio Impedance Meter.
      a. Minimum of three frequencies ranging from 250Hz to 4kHz.
      b. Range 1 ohm to 1M ohm.
      c. 10% accuracy.
      d. Direct reading of dBm across 600-ohm load.
   2. Digital Multimeter.
      a. DC to 20kHz bandwidth.
      b. 300V range.
      c. 100mV resolution.
      d. 10M ohms input impedance.
      e. DC resistance to 0.1 ohms.
   3. Dual trace oscilloscope.
      a. 450MHz minimum bandwidth.
      b. 1mV/cm sensitivity.
      c. Dual timebase capability.
   4. Sine/Square Wave Generator.
      a. 5Hz to 5kHz bandwidth.
      b. Output level of 0dBm with less than 0.5%THD.
   5. Sound Pressure Level Meter:
      a. Applicable Standards: IEC 61672-1, 60651 and 60804 Type 2, ANSI S1.4 Type 2
      b. Accuracy: ±1.5dB (ref 94dB@1KHz)

c. Resolution: 0.1dB
d. Digital Display: 4 digital LCD
e. Measurement Parameters: SPL, SPL MIN/MAX, SEL, and Leq
f. Measurement Range: 30dB to 130dB
g. Linearity Range: 100dB
h. Measurement Frequency Range: 31.5Hz to 8KHz
i. Frequency Weighting: A and C
j. Response Impulse: Fast and Slow
k. Microphone: 1/2 " Electret condenser microphone
l. Sampling time: updated every 0.5s
m. Bargraph: 4dB steps, 100dB range, 125ms update

6. Digital Video Signal Test pattern generator with output for the following signal types:
   a. Composite Video
   b. Component Video
   c. RGBHV video
   d. HDMI video (1080p 24 fps)
   e. SDI

3.7 TRAINING AND INSTRUCTION

A. General: The AVS installer shall follow all training requirements indicated in specification section 27 00 10. The AVS Installer shall provide the owner with different types of training as described herein.

B. System Administration Training. The AVS installer shall provide system administration training at the job site as described below:
   1. At least 8 hours of training shall be provided.
   2. Travel time will not be counted as part of the training sessions.
   3. Training will be broken down to a maximum of 2 sessions in different days.
   4. The objective of the system administration training will be to properly operate, trouble shoot, calibration and perform specific field repairs to AVS equipment.
   5. Field repair and calibration training will be limited to those repairs notes by the manufacturer of the equipment as field repairs done by non factory trained personnel.
   6. Training shall be done at the job site with all the equipment operational after final acceptance.
   7. Training will be limited to a maximum of 5 attendees per session.
   8. Operation and Maintenance manuals shall be delivered at the beginning of this sessions.

C. User Training. The AVS installer shall provide system administration training at the Job site as described below:
   1. At least 10 hours of training shall be provided.
   2. Travel time will not be counted as part of the training sessions.
   3. Training will be broken down to a maximum of 3 sessions in different days.
   4. The objective of the user training will be to properly operate the AVS.
   5. Training will be limited to a maximum of 20 attendees per session.
   6. User short form guides shall be provided to all attendees of the sessions.

7. Short form guides shall provide the users with quick finding ways to operate the system. If AVS operation is different from one room to the other, one separate short form guide shall be provided for each room.

D. Factory Training: The AVS installer shall provide factory training as described below:
   1. None.

3.8 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. General: The AVS installer shall follow all as built and close out information requirements indicated in specification section 27 00 10.

B. The following information shall be included in the as built drawings:
   1. Drawings indicating final floor plan locations of all AV devices
   2. One line diagrams with all devices connected in the system.
   3. Mounting details
   4. Any signed and sealed structural calculations required for the AVS

C. Additional close out information to be delivered by the AVS installer:
   1. All programming source code done by the AVS for this project for all pieces of equipment in digital format (no printed copies required).
   2. List of all IP addresses assigned to each equipment part of the AVS.
   3. Compiled executable files as requested for Computer based user interface.
   4. All printed test results.
   5. Operations manual for AV system as a whole and (1) one page Quick Reference Guide per room. Documents shall be provided as PDF as well as a laminated copy provided in room.

END OF SECTION 27 41 00

SECTION 27 41 34 - BROADBAND DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. General: Telecommunications Drawings apply to work of this section. The overall and detailed Broadband distribution design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.

C. General: Requirements indicated in the following standard apply to the work to be performed under this specification section:
   1. TIA-568-C.4 (July 2011) “Broadband Coaxial Cabling and Components Standard”. Including addendum and errata.

D. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 27 00 10 Technology General Provisions
   2. 27 05 28 Raceways for Technology
   3. 27 05 26 Grounding and Bonding for Telecommunications Systems

1.2 DEFINITIONS

A. Agile Receiver: A broadband receiver that can be tuned to any desired channel.

B. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.

C. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, it is spread out over a wider band. The carrier frequency is the center frequency on any television channel.

D. CATV: Community antenna television; a communication system that simultaneously distributes several different channels of broadcast programs and other information to customers via a coaxial cable.

E. CCTV: Closed-circuit television.

F. CEA: Consumer Electronics Association.

G. dBmV: Decibels relative to 1 mV across 75 ohms. Zero dBmV is defined as 1 mV across 75 ohms. dBmV = 20 log 10(V1/V2) where V1 is the measurement of voltage at a point having identical impedance to V2 (0.001 V across 75 ohms).

H. DOCSIS. Data Over Cable Service Interface Specification. This is an international telecommunications standard that permits the addition of high-speed data transfer to CATV system.

I. Headend: The control center of the master antenna television system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "Central Retransmission Facility."

J. MATV: Master antenna television; a small television antenna distribution system usually restricted to one or two buildings.

K. RF: Radio frequency.

1.3 DESCRIPTION

A. Broadband Distribution Systems shall provide distribution of video, television signals to all selected spaces in the buildings. The system design anticipates increasing demands for expanded channel capacity. The system shall include, but not be limited to passive and active infrastructure like distribution amplifiers, directional couplers, taps and splitters as required to achieve a fully functional system.

B. General: Provide, complete with all accessories, a complete distribution system as describe herein and as indicated on the drawings

C. Standards: Distribution system components and overall system performance shall meet or exceed the following standards:
   1. Federal Communications Commission Technical Specifications Title 47, Part 76 as applied to cable television systems.
   2. TIA – 568.4 Revision D “Broadband coaxial cabling and components”
   3. TIA-606-C, “Administration Standard for Telecommunications Infrastructure” with addendum and errata.

D. RFI: Special emphasis shall be placed on radio frequency interference (RFI) integrity as licensed radio services outside the cable system share the same frequencies designated for use within.

E. Distribution of direct broadcast satellite service signals, which includes coordinating with Owner's selected service provider for installation of its dish-type antennas and processing the signals as needed to provide specified services combined into a single-feed point ready for connection into the distribution system. Obtain signal levels, and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.

F. Intent of design drawings: The intent of the design drawings is to indicate the scope of

work of the project and to allow the installer to properly bid the project. The design drawings are based on estimated distances between devices. Once all cable are run, the installer shall measure the exact cable footages between equipment locations and shall adjust the calculations of the system to comply with the performance criteria indicated in this specification section. The installer shall change any taps, equalizers or directional couplers to match the modified calculations by the installer, at no additional cost to the owner.

G. For all CATV head end specification and requirements see section 27 41 35, this section only applies to the distribution part of the CATV system.

1.4 SERVICES SUPPORTED

A. The system configuration will allow the forward distribution of the following incoming TV signals:
   1. Analog channels from Cable provider
   2. Digital channels from cable provider
   3. High Definition channels from cable provider
   4. Digital Satellite TV.
   5. High Definition channels from Satellite TV
   6. Off – Air High Definition TV channels
   7. Internally generated programming in a central location
   8. Internally generated programming from any room with distribution outlets in the facility.

B. The system bandpass shall allow for the following channel loading and forward distribution:
   1. Sixty (60) channels from 47 MHz to 450 MHz.
   2. Seventy seven (77) channels from 47 MHz to 550 MHz.
   3. One hundred and ten (110) channels from 47 MHz to 750 MHz.
   4. One hundred and twenty nine (129) channels from 47 MHz to 860 MHz.
   5. One hundred and fifty two (152) channels from 47 MHz to 1000 MHz.

[USE NEXT, ONLY IF OPTION 8 WAS SELECTED FROM 1.5.A.8]

C. The system shall allow for a return path with a loading of 3 channels from 5 MHz to 42 MHz.

1.5 INSTALLER QUALIFICATIONS

A. Qualifications: The CATV installer installing this system shall be experienced in the design, installation, proof of performance testing and maintenance of broadband cable television systems comparable or larger in size and complexity to the system required on this project. Such experience shall be indicated in a list of successfully completed systems with the submittal for this system. Contact names and addresses for all references shall be provided.

B. Equipment: The CATV installer executing this work shall own and maintain at least the following equipment for execution and maintenance of this system;

1. A CATV signal level meter capable of measuring levels between 5 and 1000 megahertz for both digital and analog channels. For example Blonder Tongue BTPPRO-1000.
2. CATV Plant certification meter such as JDSU DSAM Wavetek Series Field Meter Model DSAM 6300
3. A flat noise generator or sweep/marker generator capable of providing a calibrated output between 5 and 1000 megahertz.
4. An oscilloscope with a suitable RF detector for use in sweep testing system response.
5. A return loss bridge and variable termination for on-site cable sweep testing prior to installation.
6. A time domain reflectometer designed for operation into 75-ohm polyethylene dielectric cable for verification of installed cable.
7. Composite test sets, simul-sweep equipment and other test systems capable of providing the required functions shall be considered equivalent to the equipment specified.
8. A stripping/coring tool appropriate for 0.500” hardline cable or larger cables.

C. Resume: A resume of personal cable television experience shall be submitted for the cable foreman, each splicer, each technician, and the system design engineer.

D. Provisions: The CATV installer shall own and maintain all necessary equipment and tooling to properly provide the system in accordance with recommendations set forth by the manufacturers of each item of system equipment.

1.6 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: See details for alternates and substitution in specification section 27 00 10.

B. Substitutions are allowed for this system only for active components, as long as they have exactly the same performance as the basis of design.

1.7 SHOP DRAWINGS AND SUBMITTALS

A. The CATV installer shall follow all requirements for shop drawings indicated in specification section 27 00 10.

B. Additional information to be included in the shop drawings
1. Cut sheet of all devices to be provided as part of this systems. When multiple devices are in the same cut sheet, the installer shall highlight the specific part number to be used. Cut sheets of the following devices shall be provided:
   a. All copper and fiber optic cables
   b. All passive devices
   c. All amplifiers to be used
   d. All connectors
   e. All outlets indicating colors
   f. All surge suppressors
   g. All fiber optics equipment

2. Proof of installer qualifications per paragraph 1.5
3. A list of all testing equipment owned by the installer as requested in this specification. The list shall include all make and model number of all devices and the last time they were calibrated.
4. Drawings indicating all outlets in the project, with cable distances included, types of cables and how they are connected to the backbone system. The drawings shall include all pad and equalization calculations to the input of all amplifiers in the system.

1.8 GENERAL SYSTEM PARAMETERS

A. Devices and products described below may or may not be required for the overall design. If such devices are required in the course of this project to achieve the design distribution parameter, the installer shall provide such devices as a part of their design solution and said devices shall be included as part of the installers package in the bid. These items would include those listed below as well as splitters, taps, couplers and pads.

B. The CATV installer shall be familiar with the ANSI/SCTE standards and shall follow those standards during the installation process.

C. Amplifiers: In most cases, the output from the amplifier shall be adequate for building distribution. However in larger building distribution systems, additional amplifiers will possibly be required. If such is the case, Input pad and equalizers shall be provided to compensate for short spacing and cable slope, respectively. Outputs shall be adjusted to the rated sloped output of the amplifier selection (typically 36 dBmv to 44 dBmv or rated output by equipment manufacturer) at the selected frequency range indicated in this specification section.

D. Output: All outlets shall provide a minimum output of between +3 dBmv and +10dBmv for the complete frequency range specified in this section.

E. Minimum acceptable distribution system performance at all outlets shall be as follows:
   1. RF Video Carrier Level: Between 3 and 12 dBmV.
   2. Relative Video Carrier Level: Within 3 dB to adjacent channel.
   3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 dB during a 60-minute period.
   4. Carrier Level Stability, Long Term: Level shall not change more than 2 dB during a 24-hour period.
   5. Channel Frequency Response: Across any 6-MHz channel in 54- to 220-MHz frequency range, referenced to video, signal amplitude shall be plus or minus 1 dB, maximum.
   6. Carrier-to-Noise Ratio: 45 dB or more.
   7. RF Visual Signal-to-Noise Ratio: 43 dB or more.
   8. Cross Modulation: Less than minus 50 dB.
   9. Carrier-to-Echo Ratio: More than 40 dB.
   10. Composite Triple Beat: Less than minus 53 dB.
   11. Second Order Beat: Less than minus 60 dB.
   12. Terminal Isolation from Television to Television: 25 dB, minimum.

13. Terminal Isolation between Television and FM: 35 dB, minimum.
14. Hum Modulation: 2 percent, maximum.
15. RF FM Carrier Level: 13 to 17 dB below video carrier level.
16. FM Frequency Response: More than the 88- to 108-MHz frequency range, signal amplitude is plus or minus 0.75 dB, maximum.
17. FM Carrier-to-Noise Ratio: More than 24 dB.

F. RF Leakage: Radio frequency leakage into the system shall be in compliance of all FCC rulings and regulations.

G. Delay: Combined reverse and forward path chroma delay, as measured at the most distant bridged port, to the headend and or main distribution point in the building and back, shall not exceed 28 nanoseconds.

H. The complete CATV distribution system shall be certified form compliance with DOCSIS 3.1.

I. All TV outlets in the project shall be provided with one UTP Category cable terminated in an RJ-45 connector at the faceplate and at a patch panel in the telecommunications room side for IPTV. This cable shall be terminated in the same telecom room as the coaxial drop and shall have the same performance, warranty and installation methods described in specification section 27 10 00 for all other voice/data drops in the project.

PART 2 - PRODUCTS

2.1 DISTRIBUTION AMPLIFIERS (NOT AT HEAD END)

A. This amplifier shall be used only in the distribution system and shall have the following specifications:
1. Frequency Range: As stated in paragraph 1.4. B of this section
2. Forward gain: 43dB
3. Gain Control Range: Greater or equal to10dB
4. Slope Control Range: Greater or equal to 8dB
5. Input Return Loss: Greater or equal to 16dB
6. Noise Figure: Greater or equal to 7dB
7. Required output Level: 36/44 dBmV,
8. Hybrid technology: Power doubling
9. Input/Output Test Point Level: -30dB

B. Design Selection: Blonder Tongue BIDA 5900 series, or approved equal with required pads and equalizers.

2.2 DISTRIBUTION AMPLIFIERS (NOT AT HEAD END) FOR LARGER SYSTEMS

A. This amplifier shall be used only in the distribution system and shall have the following specifications:
1. Forward Frequency Range: 54 to 1000 MHz

2. Reverse Frequency Ranfe: 5 to 42 Mhz
3. Forward gain: 35dB
4. Reverse gain: 20 dB
5. Gain Control Range: Through plug in pads
6. Slope Control Range: Through plug in equalizer
7. Input Return Loss: Greater or equal to -16dB
8. Noise Figure: Greater or equal to 6dB
9. Composite triple beat (CTB): -78 dBc
10. Composite Second order (CS)) -74 dBc
11. Required output Level: 37/47 dBmV,
12. Hybrid technology: Power doubling
13. Input/Output Test Point Level: -20dB

B. Design Selection: Toner TBLE-1035-42, or approved equal with external power supply and required pads and equalizers.

2.3 PASSIVE DEVICES

A. All passive devices shall have a minimum bandwidth of 5 to 1000 MHz.

B. Splitters for drops or backbones designed with RG-6 or RG-11 lines: Splitters shall be Blonder Tongue SXRS-2, 3, 4, 6 & 8 as required by the system configuration.

C. Directional Couplers fro drops or backbones designed with RG-6 or RG-11 lines: shall be Blonder Tongue SRT series, with dB TAP setting as required by the system configuration.

D. Splitters for backbones designed with PIII-500 or bigger diameter cable: shall be Toner TLP-SP series as required by the system configuration.

E. Directional couplers for backbones designed with PIII-500 or bigger diameter cable: Shall be Toner TLP-DC series as required for the system configuration

F. Multi-taps shall be Toner Total tap with 3 or 6 tap housings as indicated by the system configuration. Tap values and quantity of tap ports as indicated in system configuration

G. Equalizer. Equalizer shall be mounted in the tap housings and shall be a Toner TXMT plate. Equalizers could be mounted also inside distribution amplifiers. The value to equalize shall be as indicated in system configuration.

2.4 OUTLETS

A. The television outlet shall provide (1) "F" type barrel connector mounted alone or with other structured wiring connectors on a common face plate. Outlets shall be mounted as indicated on the documents, or as otherwise indicated and directly inline with the proposed television location. Coordinate final location based upon provided drawings and coordination with the Owner. A three wire grounded, 120 VAC power outlet shall be located adjacent to the television outlet and be provided by owner selected Division

26 Installer. Coaxial cable shall be provided by the CATV installer to each outlet location indicated on the drawings. Conduit and boxes shall also be provided according to specifications section 27 05 28. Coordinate location with electrical installer if not already provided at time of installation of this work.

B. Design selection: F- connector with a single barrel connector to match (faceplate style and color) the design selection of the structured wiring system as described in specification section 27 10 00.

2.5 VIDEO DISTRIBUTION CABLE

A. Structural Return Loss Testing: All cable shall be 100% swept tested. Return loss shall not be less than 23dB at any given frequency between 5MhZ and 1000MhZ.

B. Construction: Cable shall be constructed of a copper clad steel or solid copper center conductor, gas expanded cellular polyethylene dielectric, multiple aluminum braided shields, and an overall jacket. All cables shall have characteristic impedance of 75 Ohms.

C. Attenuation: Attenuation characteristics in decibels per 100 feet at 20oC shall not deviate more than 10% from the following values:

FREQUENCY (MHz)	RG-6	RG-11	PIII-500
5	0.57	0.36	0.16
55	1.5	0.95	0.54
211	2.87	1.81	1.09
300	3.43	2.17	1.31
400	4.0	2.53	1.53
450	4.28	2.69	1.63
550	4.76	3.01	1.82
750	5.62	3.58	2.16
870	6.09	3.9	2.35
1000	6.54	4.23	2.53

D. RG-6 Cable: No 18 AWG solid bare copper conductor. Four layers of shield, two aluminum foil-polyester tape aluminum foil, one 60% aluminum braid and one 40% aluminum braid. NEC article 820 compliant jacket suitable for the environment being installed.

E. RG-11 Cable: No 14 AWG solid bare copper center conductor. Two layers of shield, one aluminum foil-polyester tape aluminum foil and one 60% aluminum braid. NEC article 820 compliant jacket suitable for the environment being installed.

F. PIII-500: 0.109” diameter copper clad center conductor. Solid aluminum tube swaged onto a high compression micro-cellular foam dielectric core. NEC article 820 compliant jacket suitable for the environment being installed.

G. Indoor Cables: The following table indicates the design selection for all CATV cables.

Cables shall be selected according to the environment in which they will be installed:

CABLE TYPE	GENERAL (CM)	RISER RATED	PLENUM RATED
RG-6	Belden 5339Q5	Use plenum rated cable	Belden 6339Q8
RG-11	Belden 1617A	Use plenum rated cable	Belden1617AP
PIII-500	Use riser rated cable	Commscope P3 500 JCAR	Commscope P3 500 JCAP

H. Outdoor Cables: When coaxial cables are to be installed outdoors, or underground in conduit, they need to have a jacket with a water blocking compound.

I. RG-59 cable shall never be used for the distribution system.

J. For all fiber optic cables and connector for broadband distribution see specification section 27 10 00. All connector for fiber optic cables shall be APC (Angled polished connectors) type connectors.

K. For all 4-pair category cable runs used for IPTV or video distribution, all requirements and specifications indicated in specification section 27 10 00 shall be followed.

2.6 CONNECTORS AND ADAPTER

A. Site Cable Connectors: All connector shall be as recommended by the Cable manufacturer for the cable size and jacket of the cable.

B. Connectors for RG-6 cables. All connectors for RG-6 cable shall be one piece compression connectors with color coded sleeve. Design selection: Belden part number SNS1P6QS or equivalent.

C. Connectors for RG-11 cables. All connectors for RG-11 cable shall be one piece compression connectors with color coded sleeve. Design selection: Belden part number SNS1P11 or equivalent.

D. Connectors for PIII-500 cables. All connectors for PIII-500 cable shall use a 5/8” 3 pin type connector. Design selection: Amphenol ACC-500-CHT10 or equivalent.

E. Adapters. The installer shall provide all adapters to connect all different cables listed above to an F type connector or a to a 5/8” 3 pin connector, as required in the design to make complete connections. Design selection: Amphenol ACC series or equivalent.

F. Crimping: All connectors shall be installed using the connector manufacturer's recommended cutting, coring and pin crimping tools.

2.7 SURGE SUPPRESSION

A. All coaxial cables entering or exiting a building (above or below ground) shall be surge

protected as required by NEC article 820.

B. All surge suppression devices shall be grounded with an AWG-12 isolated wire to the closest electrical ground.

C. All surge suppression devices shall be UL 497 listed, gas tube suppression, power passing and specifically designed for broadband network applications.

D. Design selection: TII in-line coaxial lighting surge protector part number 212FF757225-31.

2.8 FIBER OPTIC BROADBAND TRANSMITTER

A. The fiber optic broadband transmitter (FOBT) shall be able to transmit broadband signals over a single mode fiber optic link and shall be able to accommodate a variety of different modulation formats such as AM/VSB, 8VSB, QAM, QPSK, etc. The FOBT shall use a high-power, low noise 1310 nm distributed feedback (DFB) laser diodes to transmit the signals.

B. The specifications of the FOBT shall be:
1. Channel loading: Same bandwidth as requested in part 1.4.B of this specification section.
2. Operating Wavelength: 1310 nm
3. Required Fiber Bandwidth: 1,000 Min. MHz
4. Input Return Loss: =/>16 dB @ 75 Ohm
5. Back Reflection: -50 min. dB
6. Optical Output Power: as indicated in design documents.
7. RF Input Level (110 Ch. Load): + 18 dBmV/Ch
8. CNR (-1 dBm Input, 77 Ch. Load + QAM 550-860 MHz @ -6dB Ref. Analog): ≥52 dB
9. CTB: ≥ 69 dB
10. CSO: ≥ -63 dB
11. Side Mode Suppression Ratio (SMSR): 30 dB
12. Fiber optic connector type: FC (APC) single mode
13. Mounting: rack mounted with built in power supply.

C. Design selection: Blonder Tongue FIBT series or equivalent.

2.9 FIBER OPTIC BROADBAND RECEIVER

A. The fiber optic broadband receiver (FOBR) shall be able to receive and forward incoming broadband signal and transmit sub-band signal back to the head end over a pair of single mode fiber optic links and shall be able to accommodate a variety of different modulation formats such as AM/VSB, 8VSB, QAM, QPSK, etc.

B. The optical specifications of the FOBR shall be:
1. Operating Wavelength: 1310/1550 nm
2. Optical Input Range: -8.0 to +2.0 dBm

3. Return laser power: 4.8 dBm, 3 mW
4. Input Connector: SC/APC single mode

C. The RF specifications of the FOBR shall be:
1. CNR: >52 dB
2. CSO: > 65 dBc
3. CTB: >68 dBc
4. Forward bandwidth: 54-870 MHz
5. Return RF bandwidth: 5- 42 MHz
6. Connector: type F.

D. The fiber optics broadband receiver shall always be used in conjunction with a Distribution amplifier (not at head end) to amplify the signal to be sent to the outlets.

E. Design selection: Blonder Tongue FOCN series with return path and DFB laser, and shall be provided with a power supply inserter.

2.10 FIBER OPTIC SUB-BAND RECEIVER

A. The fiber optic sub-band receiver (FOSR) shall be able to receive and forward return path broadband signal coming from the FOBR over a single strand fiber optic links.

B. The optical specifications of the FOSR shall be:
1. Operating Wavelength: 1310 nm
2. Optical Input Range: -9.0 to +4.0 dBm
3. Input Connector: FC/APC single mode

C. The RF specifications of the FOSR shall be:
1. CNR: >50 dB
2. CSO: -70 dB
3. CTB: -63 dB
4. Forward bandwidth: 5-400 MHz
5. Connector: type F.

D. Design selection: Blonder Tongue SIBR-S4A-210.

2.11 FIBER OPTIC BROADBAND COUPLER

A. The fiber optic broadband coupler (FOBC) shall be a passive device capable of splitting a broadband signal modulates in a fiber optic signal to multiple outputs.

B. The specifications of the FOBC are:
1. Number Of Inputs: 1
2. Wavelength: 1310 & 1550 nm
3. Number of Outputs: As indicated in design drawings
4. Connectors: FC/APC.

Number of Outputs	2	3	4	6	8

Insertion Loss (Individual Port):	≤3.6 dB	6.0 dB	7.3 dB	9.7 dB	10.8 dB
Uniformity:	≤0.6 dB	1.0 dB	1.0 dB	1.0 dB	1.9 dB
Directivity:	≥ 50 dB	≥ 50 dB	≥ 50 dB	≥ 50 dB	≥ 50 dB

C. Design selection: Blonder Tongue FOC-22 series.

2.12 IDENTIFICATION AND LABELING TAGS

A. The CATV installer shall follow labeling materials indicated in specification section 27 00 10.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. The CATV installer shall follow all installation practices indicated in specification section 27 00 10

B. In Raceway: All cables shall be installed in raceways without kinks, dents, or abrasions. Specified pulling strength of cable shall not be exceeded.

C. All indoor cables shall have no splices at any points.

D. Terminal Locations: Cables at terminal locations shall be neatly formed using a bending form to prevent kinks or other discontinuities. Cables showing evidence of abuse or physical damage shall be replaced at the installer's expense.

E. It is envisioned that television service will migrate into the overall telecommunications scheme for a given facility, therefore television distribution shall be accomplished via the following methods. In general, television distribution points shall be located throughout the facility and all wiring shall be run back to the Telecommunication closet where the connection to the Broadband distribution backbone will take place.

F. The facility contains telecommunications rooms or associated closets, which shall be used for amplification & distribution equipment as well as all TRUNK/FEEDER & DROP cable terminations. Cabling used shall conform to the specifications as previously outlined, with the addition of CMP type cables for use in plenum rated areas if applicable, and environmental air circulation spaces, if required by the facility air distribution system.

G. All unused outputs of splitters, directional couples or distribution taps shall have a 75 ohm termination installed.

H. All unused cavities of the Toner Total Tap housing shall be filled with blank plates

I. All equipment with a grounding lug shall be grounded as recommended by the equipment manufacturer to an acceptable grounding point as described by the NEC.

J. All amplifiers shall be used at the rated output. The installer shall provide the required equalization and attenuation pads for all amplifiers to operate at the rated output at only 80% of the maximum gain control of the unit.

K. Cable and equipment identifiers shall be provided and shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the CATV installer shall be submitted for approval to the A&E.

L. The installer shall use attenuator or adjustment for fiber optic equipment to ensure proper budget levels are getting to each receiver.

3.2 INSTALLATION OF CONNECTORS

A. Provisions: All connectors shall be installed in strict accordance with the manufacturers' instructions.

B. Residue Removal: All dielectric residues shall be removed from surfaces of center conductors to insure proper electrical contact.

C. Preparation: Semi-rigid cables shall have jacket removed to a length of 2" from the cable end to allow proper seating of connectors without scoring of the aluminum sheath. A tubing cutter shall not be used for this purpose. All flooding compound shall be removed from the connector location with a suitable solvent.

D. Connections: All connections including terminations and connections on flexible cables shall be wrench tightened to insure RFI integrity. Connectors at manhole or exterior pedestal tap locations and antennas shall be filled with Dow Corning #5 compound prior to wrench tightening.

E. Tooling: Cables shall be prepared to accept connectors using the manufacturer's recommended tooling.

F. Crimp Connections: Crimp type connections on flexible cables in manholes shall be made with a Hex crimp tool and encapsulated with flooded heat shrink tubing.

G. Heat Shrink Boot: All cables containing flooding compound shall be provided with a heat shrink boot at all termination points which covers the housing connector boss, body of the connector and extends not less than 12" along the cable jacket. Heat shrink boot shall be of the filled type.

H. Splices: Cable splices below grade or in other locations shall be made according to manufacturers' recommendations, tested, and covered with a filled heat shrink boot approximately 30" in length. Boot shall contain a resilient compound which melts as heat is applied and fills all voids between the shrink tube and cable jacket. Resin casts shall not be acceptable.

I. For termination of all Fiber optics and UTP category cable, follow all requirements indicated in specification section 27 10 00.

3.3 EQUIPMENT MOUNTING

A. Mounting: All remote terminal equipment (amplifiers, taps, couplers etc.) shall be neatly arranged and securely mounted. When installed above the ceiling all devices need to be in accessible places. All accessories required for wall mounting equipment shall be provided when equipment is to be wall mounted.

B. Integrity: All equipment housing hardware including amplifiers shall be wrench tightened to insure full RFI integrity.

3.4 SYSTEM ADJUSTMENTS

A. Installation: System design drawings are based on estimated distances between devices. The installer shall measure the exact cable footages between equipment locations and submit a revised drawing to the engineer for review containing the following;
   1. Exact footage of each cable
   2. Revised coupler and tap values
   3. Revised equalizer and pad values.

3.5 SYSTEM PERFORMANCE

A. General: Upon completion the system shall be adjusted, tested, and left in perfect operating condition.

B. Provisions: The system shall not exhibit any audible or visible components of hum, noise, or distortion.

C. Before the system acceptance test, the installer shall test all outlets in the system and document the result in a spreadsheet or an automated test print out from the test equipment. This report is called TEST RESULT REPORT (TRR). The TRR report shall include the following information:
   1. Project name and location
   2. Day test was done (if done in different days, the report shall be broken in sections by days the tests were done).
   3. Name of the installer that performed the test
   4. Serial number of the tester used.
   5. For each outlet in the project the report shall include:
      a. Room number:
      b. Room name:
      c. Outlet number (with permanent label matching as-built drawings)
      d. Lowest channel - signal level (in dBmV)
      e. Mid bandwith channel – signal level (in dBmV)
      f. Highest channel (as identified in part 1 of this specification) – signal level (in

dBmV)

6. For each amplifier in the system the report shall include:
   a. Room number:
   b. Room name:
   c. Lowest channel - signal level (in dBmV, measured @ test port)
   d. Mid bandwith channel – signal level (in dBmV, measured @ test port)
   e. Highest channel (as identified in part 1 of this specification) – signal level (in dBmV, measured @ test port)

D. All Fiber optics cables and UTP category cable shall be tested in accordance to specification section 27 10 00.

3.6 SYSTEMS WARRANTY AND SERVICE

A. General: The CATV installer shall follow all warranty and service requirements indicated in specification section 27 00 10.

3.7 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The CATV installer shall follow all test requirements indicated in specification section 27 00 10.

B. General: The Installer shall demonstrate the operation of the system to the Architect & Engineer (A&E) during the final inspection in the following manner:
   1. Measure signal levels with a calibrated field strength meter at outlets and or amplifiers selected by the A&E. At a minimum 5% of all outlets will be tested. The readings of the meter shall be between 1.5 dBmV of the value documented in the TRR
   2. Observe picture quality at outlets selected by the Engineer using a television receiver.

C. If at least one measurement fails, the A&E can request to the installer to test more outlets (beyond the 5% indicated previously) until the A&E is satisfied with the results. Any failures shall be corrected by the installer at no additional cost to the owner.

3.8 TEST EQUIPMENT REQUIRED

A. At a minimum during the acceptance test to the A&E the installer shall have the following equipment:
   1. TV Receiver: 17" minimum diagonal screen size color receiver in good working order.
   2. Signal Meter: This signal meter needs to be the same tester used during the TRR

B. Age and Calibration: Test equipment used in demonstrating system performance shall be less than 6 months old or bear the calibration seal of a recognized lab which is dated within 6 months of the date of acceptance test.

3.9 TRAINING AND INSTRUCTION

A. General: The CATV installer shall follow all training requirements indicated in specification section 27 00 10.

B. The training shall include the following topics:
   1. How to make connectors part of this system with the provided tools.
   2. How to balance the system with amplifiers at rated output
   3. A walk-through of the facility pointing out the location of all active and passive equipment part of this system and showing to the owner the as-built drawings with matching labels for those pieces of equipment.
   4. A complete training on the use of the test tool provided.

3.10 SPARE PARTS AND TOOLS

A. As part of this contract the installer of this system shall provide the following materials and tools:
   1. Twenty (20) RG-6 connectors, same make and model as the units used in this project.
   2. A new and unused crimping tool for the RG-6 connector specified.
   3. A new and unused coaxial cable stripping tool
   4. Five (5) 75 Ohm terminators (f connector)
   5. One (1) 5/8” 75 Ohms terminator.
   6. One (1) signal level meter as the one used for the TRR
   7. Two (2) surge protectors.

3.11 AS BUILT DOCUMENTS AND CLOSE-OUT INFORMATION

A. General: The CATV installer shall follow all as built and close out information requirements indicated in specification section 27 00 10.

B. General: As built drawings shall include the following information:
   1. A block diagram of the entire system indicating all cable routing and lengths
   2. Revised coupler and tap values for each cable drop
   3. All cable types, active components, and passive components.
   4. All equalizing and attenuating pads used for each amplifier.
   5. All system settings.
   6. All brands and part number of all devices shall be indicated in the drawings.
   7. Location of each outlet and the unique label identifier of each outlet.
   8. High/low signal level measured at each amplifier test port.

C. Additional information to be provided by the CATV installer, as part of the close out information:
   1. A copy of the TRR signed approved by the A&E.

END OF SECTION 27 41 34

SECTION 27 51 13 - PUBLIC ADDRESS/BACKGROUND MUSIC SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General: The following documents, apply to work of this section:
   1. 27 00 10 Technology General Provisions
   2. 27 05 28 Raceways for Technology
   3. 27 10 00 Structured Cabling System
   4. 27 05 26 Grounding and Bonding for Communication Systems

B. General: Telecommunications Drawings apply to work of this section. The overall and detailed Public Address/ Background music system referred hereinafter as the PA system design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.

C. General: Installation practices for PA system as describe herein take precedence over any other section in the construction documents set.

1.2 SCOPE OF WORK

A. The PA System (PAS) Installer shall be responsible for the complete installation of the PA System, including but not limited to the provision, fabrication and installation of the amplifier racks, microphone switching unit, microphone stations, microphones, all speakers, speaker enclosures, baffles, the wiring of all components, interfacing to existing equipment and testing/adjusting of the complete PA System.

B. For all raceways part of the PA system, see specification section 27 05 28.

1.3 SYSTEM DESCRIPTIONS AND REQUIREMENTS

A. The PA system is composed of the following components and subsystems:
   1. Paging stations
   2. Microphone audio/control distribution system
   3. Audio switching and control system.
   4. Digital Signal processing systems and components
   5. Power amplifiers
   6. Speakers
   7. Test and monitoring system and components
   8. Racks, cabinets and accessories.

B. When the proposed system uses structured wiring infrastructure, including but not limited to premises UTP or STP cable, fiber optic cables, backbone copper cables,

patch panels, telecommunications outlets, punchdown blocks; all specifications given in section 27 10 00 shall apply to this part of the work.

1.4 INSTALLER QUALIFICATIONS

A. General: The PAS installer selected for the Project must be certified by the manufacturers of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturers components and distribution channels in provisioning the Project.

B. General: The PAS installer directly responsible for this work shall be a "Audio Visual System Installer" who is, and who has been, regularly engaged in the providing and installation of commercial and industrial audio visual systems of this type and size for at least the immediate past five years. Any sub Installer who will assist the PAS installer in performance of this work, shall have the same training and certification as the PAS installer.

C. Certification: The PAS installer's Project Manager shall possess a current BICSI Registered Communications Distribution Designer (RCDD®) certificate or an ICIA® Certified Technology Specialist (CTS) designation. All shop drawings submitted by the installer shall bear the RCDD's stamp or the name of the CST.

D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and testing audio visual systems and have personnel who are adequately trained in the use of such tools and equipment. The Owner or engineer may elect to request submittal of additional financial, operational and administrative information of the installer to demonstrate the required experience.

E. The Installer shall possess a State of Idaho Low Voltage License.

F. The Installer shall maintain a permanent office within 150 miles of the project site.

G. A current certificate of insurance meeting the Owner minimum insurance requirements.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: See details for alternates and substitution in specification section 27 00 10.

B. Substitutions are allowed for this system as long as all substitutions do not represent and change in architecture and have exactly the same performance as the basis of design.

1.6 SHOP DRAWINGS AND SUBMITTALS

A. The PAS installer shall follow all requirements for shop drawings indicated in

specification section 27 00 10.

B. General: Submittals shall include manufactures cut sheets for all proposed equipment. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting. The followings items shall be submitted:
   1. All wire and cable.
   2. All connectors and required tooling.
   3. All termination system components for each cable type.
   4. All Active and passive hardware components.
   5. All software components
   6. All grounding and surge suppression system components for the systems portion of the project.

C. A resume of qualifications shall be submitted with the installer's bid indicating the following:
   1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
   2. A list of test equipment proposed for use in verifying the integrity of the installed distributive information local area network system.
   3. A technical resume of experience for the installer's engineer/RCDD and on-site foreman who will be assigned to the project.
   4. Similar documentation for any sub installer who will assist in the performance of this work.

1.7 WORK EXTERNAL TO THE BUILDING

A. General: Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification.

PART 2 - PRODUCTS

2.1 PAGING STATIONS

A. General: The purpose of the paging stations is to initiate a page in the system. Refer to design drawings to identify the different types of paging stations.

B. When paging stations require a non-standard (standard meaning a gangable electrical box) backbox for the installation, the PAS installer shall provide them as part of this contract. The PAS installer shall provide as well any other accessories required for the correct operation or mounting of the page stations, including but not limited to power adapters, mounting clips, connectors, anchors, etc.

2.2 MICROPHONE AUDIO/CONTROL DISTRIBUTION SYSTEM

A. General: The purpose of the microphone audio/control distribution system is to transmit the audio/control and test signals from the paging stations to the audio switching and control system. This system could be composed of active or passive components, as described in the design drawings.

B. Audio signals shall be distributed from the paging station to the audio switching and control systems by means of a twisted pair 100% shielded cable, made of stranded copper conductors with a AWG-22 Tinned copper drain wire. The gauge of this cable shall be selected according to the distance of the cable run, to ensure a less than 5% of signal loss. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.

C. Control signals shall be distributed from the paging station to the audio switching and control systems by means AWG-22 twisted pair 100% shielded cable, made of stranded copper conductors with an AWG-22 Tinned copper drain wire. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.

D. For desktop mounted paging stations, the above mentioned cables shall be terminated in an outlet box with XLR type connectors. The paging stations shall have a flexible cord or a rubber insulated cable terminated with the corresponding mating connectors in the paging station and the outlet box.

E. The audio and control signals from the paging stations to the audio switching and control systems shall be transmitted by analog means to an Ethernet gateway, and from this gateway shall use digital means to get to the audio switching and control system.

F. Audio signals shall be distributed from the paging station to the Ethernet gateway by means of a twisted pair 100% shielded cable, made of stranded copper conductors with a AWG-22 Tinned copper drain wire. The gauge of this cable shall be selected according to the distance of the cable run, to ensure a less than 5% of signal loss. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.

G. Control signals shall be distributed from the paging station to the Ethernet Gateway by means AWG-22 twisted pair 100% shielded cable, made of stranded copper conductors with an AWG-22 Tinned copper drain wire. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.

H. For desktop mounted paging stations, the above mentioned cables shall be terminated in an outlet box with XLR type connectors. The paging stations shall have a flexible cord or a rubber insulated cable terminated with the corresponding mating connectors in the paging station and the outlet box.

I. The Ethernet gateway shall be a multiple input device (quantity of inputs as indicated on design drawings) capable of delivering hi fidelity audio signals to the audio switching and control system by means of an Ethernet network. The specifications of the Ethernet gateway are:
   1. Signal types: It shall be able to upload microphone or line level analog audio

signals.
2. Power: It shall be capable of sending 48 VDC phantom power to the paging stations.
3. Frequency response: 20 Hz – 20 KHz with a +4 dBU input signal.
4. Total harmonic distortion: 0.01% @ 1KHz with a +4 dBU input signal.
5. Dynamic range: 78 dBA for mic level signals, and 95 dBA for line level signals
6. Input gain: software controllable from -9 dB to +60 dB, in 1 dB increments.
7. A/D quantization: 24-bit resolution.
8. Audio sampling: 48 KHz
9. Communication protocol: Cobranet™ over 100Base T Ethernet link.

J. The wiring of the system from the Ethernet gateway to the audio switching and control system shall be by means of UTP cable or fiber optics, according to design drawings. The PAS installer shall follow all specifications of section 27 10 00 to do this wiring.

K. All networking equipment required to communicate from the Ethernet gateway to the audio switching and control system, including but not limited to switches, routers, media transceivers or gateways shall be provided by the owner.

L. The audio and control signals from the paging stations to the audio switching and control systems shall be transmitted by UTP or fiber optic cables as indicated in the design drawings. The PAS installer shall follow all specifications of section 27 10 00 to do this wiring.

2.3 AUDIO SWITCHING AND CONTROL SYSTEM

A. General: The purpose of the Audio switching and control system is to route the page announcements from the paging stations to the user selected output zones.

2.4 DIGITAL SIGNAL PROCESSING SYSTEM AND COMPONENTS

A. General: The purpose of the digital signal processing system is to filter, limit, or alter the original audio input on any desired way to enhance the audio response of the page announcement or background music by means of DSP active equipment.

B. The digital system processing system shall be 100% software controllable with 4 or 8 multiple audio inputs and outputs. The control software shall be installed on a standard PC, and shall provide complete display and control in graphical form, of all signals processing configurations and functions. Once the system is programmed, the unit shall be capable of storing the configuration in non-volatile memory.

C. The digital signal processing system shall be configurable to utilize a variety of signal processing algorithms, including but not limited to:
1. Input and output gain control with meters.
2. Parametric bandpass, all-pass, high and low shelf & cut filters.
3. Feedback suppression.
4. Graphic equalization
5. Crossovers

6. Compression, limiting, automatic gain control, ambient noise compensation.
7. Mix, select, level control and delay.
8. Pink noise and sine wave generation.

D. The data conversion of the digital signal processing system shall be 24-bit, 48 KHz sampling rate.

E. The unit shall meet UL/CSA and CE safety requirements.

2.5 POWER AMPLIFIERS

A. General: The purpose of the power amplifiers is to amplify all audio signals to be transmitted to the speakers. The power amplifier shall be a 70V direct constant voltage unit with the following features:
1. Power supply shall be of the switching type.
2. Rack mountable with cooling fans for front to back, or side to side ventilation.
3. Input sensitivity independent for each channel.
4. Unit shall have protection circuits for amplifier overheat, shorted outputs, DC, mismatch loads, under/over voltage, high frequency overloads and internal fault.
5. Switchable high-pass filter per channel, to eliminate step down transformer saturation at low frequencies.
6. Comprehensive indicators array for Power, Data, Read, Signal, Thermal and Fault.
7. Unit shall be UL listed

B. Power handing: All amplifiers shall be seized to handle 75% of the total load of the speaker's line.

C. The audio handing performance of the power amplifiers shall be:
1. Frequency response: 20Hz to 20Kkz ± 1dB @ 75% of the rated power.
2. Signal to Noise ratio: 105dB A-weighted below power rating from 20Hz to 20kHz.
3. Total Harmonic Distortion (THD): <0.4% @ rated power from 20HZ to 20Khz.
4. If unit has two or more channels. Crosstalk: >80dB, below rated power from 20Hz to 1kHz.
5. Common mode rejection ratio (CMRR): >40 dB from 20Hz to 20kHz.
6. Damping factor: >1000 (Use 13 for IED systems)

D. Amplifiers shall be of switching type.

E. Amplifier shall be capable of being monitored from the test and monitoring system through a 100Mb Ethernet connection.

2.6 SPEAKERS

A. General: All speakers shall include a 70V transformer. Speakers are classified in types according to the location where they will be installed. The design drawings indicate all different types and locations in the floor plan.

B. SPEAKER TYPE 10: This speaker type shall be used for ceiling lower than 10 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 10 shall have the following specifications:
   1. Speaker: 4” coaxial loudspeaker with a 25W power rating
   2. Woofer construction: Poly cone butyl rubber.
   3. HF driver construction: PEI dome tweeter.
   4. Frequency response: 75Hz to 20Khz
   5. Sensitivity: 88 dB average.
   6. Magnet weight: minimum of 10 oz.
   7. Voice coil diameter: 1 inch
   8. Transformer tabs: 1,2,4,8 and 16 W.
   9. Enclosure: acoustically treated, front loading with a minimum depth of 7”.Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
   10. Grill: shape, finish and color shall be coordinated with the architect.
   11. Basis of design: Atlas soundolier model FAP42T

C. SPEAKER TYPE 11: This speaker type shall be used for ceilings between 16 ft. and 10 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 11 shall have the following specifications:
   1. Speaker: 6” coaxial loudspeaker with a 50W power rating
   2. Woofer construction: Poly cone butyl rubber.
   3. HF driver construction: PEI dome tweeter.
   4. Frequency response: 63Hz to 20Khz
   5. Sensitivity: 88 dB average.
   6. Magnet weight: minimum of 14 oz.
   7. Voice coil diameter: 1 inch
   8. Transformer tabs: 2,4,8,16 and 32 W.
   9. Enclosure: acoustically treated, front loading with a minimum depth of 7”.Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
   10. Grill: shape, finish and color shall be coordinated with the architect.
   11. Basis of design: Atlas soundolier model FAP62T

D. SPEAKER TYPE 12: This speaker type shall be used for ceilings between 25 ft. and 16 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 12 shall have the following specifications:
   1. Speaker: 8” coaxial loudspeaker with a 70W power rating
   2. Woofer construction: Polypropylene cone & SBR surround.
   3. HF driver construction: PEI dome tweeter.
   4. Frequency response: 55Hz to 20Khz
   5. Sensitivity: 90 dB average.
   6. Magnet weight: minimum of 21 oz.
   7. Voice coil diameter: 1 inch
   8. Transformer tabs: 1.9, 3.8, 7.5, 15, 30 and 60 W.
   9. Enclosure: acoustically treated, front loading with a minimum depth of 7”.Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
   10. Grill: shape, finish and color shall be coordinated with the architect.
   11. Basis of design: Atlas soundolier model FAP82T

E. SPEAKER TYPE 13: This speaker type shall be used for ceilings between 50 ft. and 25 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 13 shall have the following specifications:
   1. Speaker: 12” coaxial loudspeaker with a 250W power rating
   2. LF driver construction: 12” diaphragm.
   3. HF driver construction: 2.5” diaphragm with 20 oz magnet.
   4. Frequency response: 33Hz to 21Khz
   5. Sensitivity: 117 dB average.
   6. Magnet weight: minimum of 70 oz.
   7. Voice coil diameter: 2.5 inch
   8. Transformer tabs: 7.5,15,30 and 60 W.
   9. Enclosure: acoustically treated, front loading with a minimum depth of 15”.Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
   10. Grill: shape, finish and color shall be coordinated with the architect.
   11. Basis of design: Atlas soundolier model 12CXT60 with Q4812 enclosure

F. SPEAKER TYPE 20: This speaker type shall be used for wall mount applications in small rooms. Speaker type 20 shall have the following specifications:
   1. Woofer Speaker: 5.25” polypropylene cone with rubber surround and 20 oz. magnet
   2. Tweeter speaker: 1” Mylar diaphragm with a 1.39 oz. magnet.
   3. Frequency response: 85Hz to 20Khz
   4. Sensitivity: 90 dB average.
   5. Transformer tabs: 0.94, 1.9, 3.7, 7.5, 15 and 30 W.
   6. Accessories: mounting bracket included.
   7. Color: black or white, selection by architect.
   8. Basis of design: Atlas soundolier model SM52T

G. SPEAKER TYPE 21: This speaker type shall be used for wall mount applications in large rooms. Speaker type 21 shall have the following specifications:
   1. Woofer Speaker: 8” hycone treated paper cone with treated cloth surround and 30 oz. magnet
   2. Tweeter speaker: 1” titanium diaphragm with a 13 oz. magnet.
   3. Frequency response: 65Hz to 20Khz
   4. Sensitivity: 92 dB average.
   5. Transformer tabs: 1.9, 3.8, 7.5, 15, 30 and 60 W.
   6. Accessories: mounting bracket included.
   7. Color: black or white, selection by architect.
   8. Basis of design: Atlas soundolier model SM82T.

2.7 TEST AND MONITORING SYSTEM AND COMPONENTS

A. General: The purpose of the test and monitoring system is to allow the system’s user to test and troubleshoot the PA system.

B. The test and monitoring system shall be capable of monitoring and testing the following subsystems of the PA system:
   1. Paging stations (Only in IED systems)

2. The microphone audio/control distribution system (Only for IP based systems)
3. The audio switching and control system.
4. The digital signal processing system.
5. The Power amplifiers
6. The speaker lines coming out of the amplifier.

C. The paging stations shall be capable on creating an audio tone that will be tested throughout the complete PA system line to check all components. The tone shall be triggered by the test and monitoring system automatically and the time and dates for those events shall be programmable. (For IED systems)

D. The PA system shall have a paging station and a rack mounted speaker at the headend location for troubleshooting purposes. From this page stations it shall be possible to do local pages in each system zone as well as any other type of general pages that are available in other stations in the system.

E. The audio hubs in the microphone audio/control distribution system shall be capable of testing through the IP network by means of a ping command. The units shall also have indicators built-in to display the strength of the audio signal coming in or out of the unit. (For IP based system)

F. The audio switching and control system as well as the digital signal processing system, and the power amplifiers shall be monitored through software.

G. The power amplifiers shall report alarms like power supply temperature, thermal level meters, fault reports and speaker line shorted or open reports.

H. The monitoring station shall be rack mountable and shall display all systems alarms in an event log window.

2.8 RACKS, CABINETS AND ACCESSORIES

A. General Description:
1. The installer shall supply a system of vertical racks capable of supporting specified electronics.
2. The cabinets shall be comprised of interchangeable modular components capable of being configured in a variety of heights either as a single unit or as a series of connected units.
3. Side components shall offer ventilation. The bottom shall be open with closure panel available.
4. Rack rail options shall include both punched and tapped (threaded) holes.
5. Model options shall include those that are welded and shipped as an assembled unit or those that are shipped knocked down and assembled on site

B. Standards:
1. The system shall preferably comply with Underwriters Laboratories (U.L.) listing. Copy of the U.L. certificate of approval to be submitted upon request.
2. The system shall comply with Electronic Industry Association (E.I.A.) specifications for rack mounting ANSI/EIA standard RS-310.

C. Modular pre-engineering construction:
   1. All components within each rack cabinet shall be:
   2. Of pre-engineered construction i.e: constructed from a series of independent components.
   3. Available from a pre-defined set of manufacturer's component model numbers or as a single model number representing a complete cabinet.
   4. In common production for at least two years prior to the date of submission.
   5. Free from alterations to the installed cabinet or series of cabinets, will be accomplished without the need for either welding or carpentry work.
   6. Capable of cables or conduits passing through the entire width of a series of connected vertical cabinets without obstruction.
   7. Capable of supporting E.I.A. standard 19"(483mm) width rack mounted equipment.
   8. Constructed of 14 and 18 gauge (.074" and .047") steel superstructure framework with external attachable side, top, rear, and bottom panels 20 gauge (.036") sides, 14 gauge (.074") base, 20 gauge (.036") tops, and 14/18 gauge (.074"/.047") combo for frames.
   9. Constructed of 14 gauge (.074) steel inner and outer rack rails.
   10. Supplied with a series of standard vented or solid blank panels which are determined by the installer and included to cover areas not filled in with specified equipment. These panels shall be measured in standard rack unit multiples and available with standard part numbers for future changes to the system.

D. Optional accessories and mounting hardware:
   1. A full range of optional accessories are available including but not limited to: Caster kit, electrical outlet supply, anti-tip extension legs, shelf support brackets, stationary shelves, pullout shelves, rack slide kits, drawers, blowers and cooling fans, corner fillers and spacers.
   2. Mounting hardware for the specified electronics shall be available upon request. Panel bolts, washers and clips with captive nuts suitable for use with E.I.A. standard punched racks shall be included.
   3. Slide kits where appropriate (including drawers) shall be of ball bearing operation. Friction or roller type slides are not acceptable.

E. Uninterrupted power supply:
   1. All racks shall include a UPS unit cable of handling the power requirements of that specific rack where they are installed.
   2. The UPS shall have remote monitoring capabilities through and Ethernet connection.

2.9 BASIS OF DESIGN

A. The Project Documents have been developed, in conjunction with the Owner, to establish a benchmark level of performance and reliability. Deviations from the basis of design (including deviations for manufacturers stated herein as "acceptable" alternates) must be in accordance with the substitution requirements of Section 27 00 10. Use of an alternate product, whether or not it is stated as "acceptable" herein, does not relieve the Installer of their responsibility to comply fully with the entirety of the Project Documents.

2.10 IDENTIFICATION AND LABELING TAGS

A. The PAS installer shall follow labeling materials indicated in specification section 27 00 10.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. The PAS installer shall follow all installation practices indicated in specification section 27 00 10.

B. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.

C. All wiring terminals, connectors, punch down blocks shall be clearly labeled and numbered. These designators shall be shown on the "as built" drawings. The labeling process shall be consistent with any owner standard or if non-existing, it shall comply with ANSI/TIA/EIA-606 C “Administration Standard for Telecommunications Infrastructure of Commercial Buildings”.

D. All major components installed in the equipment racks shall be equipped with engraved or photo laminated labels identifying area(s) served by that device. The labels shall correspond with designators on the "as built" drawings.

E. Physical integrity of cables shall pass not only electronic testing but visual inspection as well by the Owner and/or the Engineer.

F. Only a single point of ground, located at the amplifier cabinets shall be used.

G. All wiring shall be separated as far as practical relative to signal levels (microphone level, speaker level and AC power). None of these different groups of cables may share a common raceway or wiring trough.

H. All speaker lines shall be terminated in screw type terminal blocks located on DIM rails inside the equipment cabinets. All microphone cables shall be terminated on rack mounted 110 punchdown blocks, at least four (4) feet away from speaker line terminations.

I. All connections to screw type terminals shall be made only by spade lugs, crimp fastened to wire.

J. Splices within conduit runs, or cable trays shall not be permitted.

K. Amplifier cabinets shall be properly grounded.

L. All active equipment for the PA system shall be protected by power surge suppressors and backed up with UPS power.

3.2 PA SYSTEM INSTALLATION

A. The Installer shall install and wire all speaker enclosures, speakers, baffles and microphone stations as shown on the drawings. Speaker enclosures shall be stuffed with 5/16" thick sound deadening acoustic batting with a density of 2 lb/cu.f t, and features an acoustic fiber board bottom to prevent “oil canning”. For 12” speakers the enclosure shall have a 1.5” fiberglass liner.

B. All ceiling mounted speakers shall be installed with a safety support to a solid building structure.

C. All ceiling mounted speakers shall be provided with the corresponding supports to mount in dry wall ceiling or acoustical tile ceilings.

D. The PAS installer shall make provisions for adding supports to the speaker’s backboxes in case the ceiling structure can’t support the weight of the speaker/backbox assembly.

E. All output zones shall be included in the digital signal processing systems. The PAS installer shall program this system until the owner is satisfied with the sound output. All programming tools and software shall be delivered to the owner as part of the hand-over process. The final system configuration of the digital system processing system shall be documented and delivered to the owner as part of the as-built documentation.

F. The Installer shall fabricate and install the amplifier racks, including all components. Spare equipment shall be installed in racks as shown on the drawings.

3.3 SERVICE SLACK

A. All PA system cable runs shall not contain service slack prior to the termination point at the head-end equipment side. Service slack at PA rooms shall consist of a 10 foot slack section located and placed neatly in the cable ladder above the equipment rack in an extended large diameter loops or in a loose figure 8 configurations.

3.4 CONDUIT INSTALLATION AND WIRING

A. Minimum conduit size shall be 3/4 inch, except the small section of flex conduit linking the speaker enclosure to the ceiling mounted J-box above the speaker. This short section of flex conduit can be sized ½”.

B. All speaker and microphone wiring shall be run in conduit. Size of the conduit shall be in compliance to National Electrical Code (NEC) and local codes fill ratios.

C. PA system installer shall provide all conduit, wiring and supports materials required by the system.

D. Conduits shall be installed by the Installer for all “home run” wiring and at all areas.

E. Minimum conduit size shall be 3/4 inch, except the small section of flex conduit linking the speaker enclosure to the ceiling mounted J-box above the speaker. This short section of flex conduit can be sized ½".

F. All speaker and microphone wiring shall be run in conduit. Size of the conduit shall be in compliance to National Electrical Code (NEC) and local codes fill ratios.

G. All conduit runs shall follow specifications in section 27 05 28.

H. The Installer shall install all cable trays and wiring as required for the installation of the audio racks.

I. All speaker wires shall have and overall shield and the wire size shall guarantee a maximum of two 2% voltage drops to the farthest speaker in a zone. Minimum wire size shall be AWG-18 in all cases.

J. All microphone audio and control lines wire shielding and sizing shall be in accordance to system vendor recommendations and standard distance limitations.

K. All PA system cabling using UTP cable or fiber optics cables shall comply with section 27 10 00 specifications for all requirements.

3.5 REQUEST OF IP ADDRESS

A. General: The PAS installer shall follow all requirements indicated in specification section 27 00 10 for the request of IP addresses for devices part of the PAS.

3.6 SYSTEMS WARRANTY AND SERVICE

A. General: The PAS installer shall follow all warranty and service requirements indicated in specification section 27 00 10.

3.7 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The PAS installer shall follow all test requirements indicated in specification section 27 00 10.

B. As part of the Engineer's final acceptance the following activities will be executed by the Engineer:
   1. Test all microphones in the system and all their features
   2. Test for audio at all speakers with a SPL meter
   3. Any other test the engineer deems necessary to establish the system is operating properly.

3.8 TEST EQUIPMENT REQUIRED

A. Sound pressure level meter with the following characteristics:
   1. Applicable Standards: IEC 61672-1, 60651 and 60804 Type 2, ANSI S1.4 Type 2

2. Accuracy: ±1.5dB (ref 94dB@1KHz)
3. Resolution: 0.1dB
4. Digital Display: 4 digital LCD
5. Measurement Parameters: SPL, SPL MIN/MAX, SEL, and Leq
6. Measurement Range: 30dB to 130dB
7. Linearity Range: 100dB
8. Measurement Frequency Range: 31.5Hz to 8KHz
9. Frequency Weighting: A and C
10. Response Impulse: Fast and Slow
11. Microphone: 1/2 " Electret condenser microphone
12. Sampling time: updated every 0.5s
13. Bar graph: 4dB steps, 100dB range, 125ms update

B. A pink noise audio source to be played in the system to check SPL.

3.9 TRAINING AND INSTRUCTION

A. General: The PAS installer shall follow all training requirements indicated in specification section 27 00 10.

B. The PAS installer shall provide for Factory training for all hardware and/or software components. The installer shall provide for a week of training for three employees at the Manufacturer's facilities. The scope of the training shall include design, operation and maintenance of the system installed. The detailed schedule of the training shall be submitted by the installer no later than 10 days after a contract is signed.

C. The training for this system shall include:
1. User system operation training: Three sessions of two to three hours each, of user system operation on site to a maximum of fifteen attendants per session. Each session shall cover the same topics. One set per attendant of basic user operation material shall be delivered by the PAS installer.
2. System administration training: Three sessions of at least four hours of system administration training on site to a maximum of five attendants per session. One set per attendant of System Administration material shall be delivered by the PAS installer.

3.10 SPARE PARTS AND TOOLS

A. Prior to completion of this project the PAS installer shall provide spare parts for this system as referenced below. All spare parts provided for this project must be new hardware. Factory serviced or reconditions components shall not be acceptable. All equipment must be made available for inspection prior to delivery. Provide an inventory record of all spare parts to avoid any discrepancies. The delivery date shall be coordinated with the owner to ensure that secure storage of these parts can be provided upon receipt. The spare parts to be provided are:
1. Paging stations: complete quantity of each type.
2. Speakers: complete quantity of each type.
3. List all other equipment.

3.11 AS-BUILT DOCUMENTATION AND CLOSE OUT INFORMATION

A. General: The PAS installer shall follow all as built and close out information requirements indicated in specification section 27 00 10.

B. As-built documentation shall include:
   1. Floor plans with all speakers, microphones, conduits and boxes shown and numbered as installed.
   2. All cable routings (trunk lines) and elevations of each TR or ER indicating outlet, tie, and riser cable terminations shall be required.
   3. All addendum information or project revisions resulting in drawing changes that occur during the construction period shall be documented and included in the as-built material.
   4. All rack elevations and mounting details.
   5. The PAS Installer shall provide a spreadsheet with the following information:
      a. For speakers: speaker model, speaker number, zone, location and transformer tab used.
      b. For microphones and sense microphones: microphone model, microphone number, zone, location and marking of the cables that the microphone uses.

C. The close out information shall also include:
   1. Submission and Approval of test reports.

END OF SECTION 27 51 13

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SECTION 28 05 37 - SECURITY VOICE COMMUNICATIONS - DISTRIBUTED ANTENNA SYSTEM

PART 1 – GENERAL

1.1 SCOPE OF WORK (SOW)

A. The scope of work of this specification describes technical and performance criteria for deploying a Security voice communications systems Neutral-Host Distributed Antenna System (DAS) capable of supporting Public Safety Networks (PSN). The DAS components specified in this document include devices such as: Donor Antennas, Coverage Antennas, Coax Cable, Coax Connectors, lightning protectors, grounding kits for coaxial cables, Splitters, Combiners, Couplers, , Bi-Directional Amplifiers (BDA), Fiber-Optic Cable, Fiber-Optic Connectors, Fiber-Optic Jumpers, Fiber-Optic Master Unit and Fiber-Optic Remote Units.

B. Because of the substantial differences in topologies available in the market for DAS, the design drawings and specifications are not meant to be a set of construction drawings, but a performance criteria base to be used by the Radio Frequency System (RFS) installer of this system to create the final construction and permit documents. It is therefore in the scope of work of this system to provide a complete design for the review of the architect and engineer (A&E) of the project.

C. The scope of work also includes the following services:

1. A software model of the building to determine the best locations of all the coverage antennas including heat map representations and modeling of all the different construction materials used in the construction of this building. Examples of this software is the modeling software offered by IBwave Systems.
2. A wireless survey done with a spectrum analyzer of all areas of the building to verify and ratify the final locations of coverage antennas, before the system is installed but the structure of the building is already installed.
3. A final survey of the building after the system is installed to verify and document in drawings all measured signal levels in all areas of the building (approximately one measure point for every 100 sqft. in the building at all levels).

D. The scope of work includes, all submittal indicated in the documents, programming of the system, coordination with other trades in the job site, warranties, testing and as-built documentation.

E. It is also the responsibility of the RFS installer to mediate and process the agreement to re-broadcast the DAS frequencies between the building owner and Public Safety First Responders Support Entity (PSN FRSE). This entity is the agency/department who maintains and supports the radio communications infrastructure for the First Responders (Fire Rescue, Police and EMS) a local jurisdiction.

1.2 RELATED DOCUMENTS

A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. All UTP 4-pair Cabling and Single Mode fiber optic cabling used in this project for the DAS shall be supplied and installed as per specification section 27 10 00.

C. All raceways and conduits used in this project for the DAS shall be governed by specification section 27 05 28.

1.3 SYSTEM DESCRIPTION

A. This specification outlines an In-Building Wireless (IBW) Distributed Antenna System (DAS). The system must extend wireless services digitally throughout the building. The system must be flexible, scalable, multi-band and multi-protocol solution.

B. The system platform shall be scalable to allow for easy system growth in size and scope of solution to reach new in-building service areas or to add bandwidth and capacity as necessary.

C. The system must support the technologies used by the PSN FRSE in the area where the project is installed providing edge-to-edge bandwidth for all frequencies used by them. It must also offer an element management system that includes on-site or remote accessible system alarming and management of network elements.

D. Services: Upon commissioning, the DAS shall provide coverage for the PSNs listed below on all frequencies currently being used by this system.

1. 800 MHz PSN coverage and all PSN FRSE frequencies.

E. PSN Approval: The RFS Installer shall propose and deploy a DAS system capable of receiving approval by the Public Safety Network Authority Having Jurisdiction PSN AHJ. The DAS shall also be in compliance with NFPA 72 and NFPA 1221.

F. Architecture. The architecture of the system shall be based on donor antennas located in the exterior of the building, feeding one or more Bi-Directional Amplifiers (BDA). These BDAs shall feed the distribution system and the local antennas that radiate the signal in both directions to the hand held devices used by the PSN FRSE. Architectures based on twisted pair cable to the distribution antennas or distribution antennas that require local power shall not be acceptable

G. Coverage: Different from what is required in NFPA codes, the DAS shall be designed to provide 100% coverage of the building with the minimum signal levels required by the prevailing code for the area where the project is located.

H. Broadband Active Distribution: If the building area is very large and amplification is required to cover some areas, the design shall include the use of single-mode fiber-optic cable for active distribution. In-line copper amplifiers are not allowed. Coverage antennas requiring local power supplies will not be allowed. All power for coverage antennas must come from the DAS head end system.

I. Supervision: The DAS system shall be monitored by the Fire Alarm system to comply with NFPA 1221 requirements. The RFS installer shall coordinate with the installer of the Fire Alarm system for proper integration.

J. Management: The DAS system shall be provided with a web-browser management interface that allows configuring, management and error reporting of active equipment part of the DAS system.

1.4 RFS INSTALLER QUALIFICATIONS

A. The installer of this system (RFS Installer) shall be a company regularly engaged in the installation of this type of system for the last five (5) years.

B. The RFS installer shall have had installed at least 20 systems similar to this one, in the last five (5) years. The RFS installer shall provide a list of completed projects with contact information from the end user side.

C. The RFS installer shall have a local service office within 100 miles of the project site.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: See details for alternates and substitution in specification section 27 00 10.

B. There are no acceptable substitutions for any parts of this system.

1.6 SUBMITTALS

A. The RFS installer shall follow all requirements for shop drawings indicated in specification section 27 00 10.

B. Submittal Requirements:

1. RFS Installer qualifications
2. Product Data: Submit manufacturer datasheets for the following components:

    a. Donor and Coverage Antennas
    b. Coaxial Cable and Connectors
    c. Splitters, Combiners and Couplers
    d. Bi-Directional Amplifiers (BDA)
    e. Fiber-Optic Master Unit
    f. Fiber-Optic Remote Units

3. Shop Drawings: Submit the following items:

    a. RF link budget
    b. Signal to Noise Interference Ratio (SNIR) Map
    c. Overlay of system Components on floor plans
    d. Drawings for Donor Antenna and grounding
    e. Bill-of-Material (BOM)
    f. Heat maps for all frequencies
    g. Battery calculations for the DAS
    h. Complete IBwave reports

4. Statement of Work (SOW): Submit sample SOW
5. Acceptance Test Plan (ATP): Submit sample ATP
6. Recommended Spares
7. Maintenance Service Pricing
8. Warranty Documents:

    a. Submit for all manufactured Components specified in this Section.
    b. Submit RFS Installer's System Warranty.

1.7 ABBREVIATIONS AND ACRONYMS

A. ACG: Automatic Gain Control

B. AHJ: Authority Having Jurisdiction

C. ATP: Acceptance Test Plan

D. AWS: Advanced Wireless Service

E. BDA: Bi-Direction Amplifier

F. BOM: Bill-of-Material

G. BRS: Broadband Radio Service

H. C/N: Carrier-to-Noise Ratio

I. DAS: Distributed Antenna System

J. FCC: Federal Communications Commission

K. GUI: Graphical User Interface

L. MTBF: Mean Time Between Failure

M. NFPA: National Fire Protection Association

N. NMS: Network Management System

O. PCS: Personal Communications System

P. PSN: Public Safety Network

Q. RoHS: Restriction of Hazardous Substances

R. RSL: Received Signal Level

S. SNIR: Signal-to-Noise Interference Ratio

T. SOW: Statement of Work

U. VSWR: Voltage Standing Wave Ratio

1.8 DEFINITIONS

A. Acceptance: Expressed approval by the customer

B. Active: DAS components that require AC/DC power for operation

C. Carrier Approval: Expressed approval to interconnect to the WSP macro network

D. Channel: A path for an RF transmission between two points

E. Component: A main system element of the DAS

F. Passive: DAS components that do not require AC/DC power for operation.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Donor signal. For this project the Donor signal will not come from a roof mounted donor antenna but from a hardwired connection to an existing DAS head end.

B. Broadband Donor Antennas: Selected based on signal survey.

C. Omni-Directional Coverage: Omni-Directional Coverage antennas shall feature a multi-band design, accommodating multiple frequency bands in a single small antenna. This antennas shall be selected based on the system architecture and based on the software modeling.

D. For all fiber optic passive components specification section 271000 shall be followed.

E. Splitters, Combiners, Couplers, Coax Jumpers and Connectors:

1. Approved Manufacturer: Commscope, Times Microwave Systems or equivalent.

F. Bi-Directional Amplifier (BDA): The BDA for this project shall be a unit capable of receiving and transmitting any RF life safety signal within the frequency range of the DAS system without any changes in protocols, or any data conversion. The BDA shall have the following specifications:

1. Enclosure: NEMA 4X, painted red
2. Bandwidth: The unit shall work in the 700/800 MHz band and FirstNet LTE Band
3. Class: Class A (Digital Channelized)
4. Channels per band: 32
5. Power per band: 2W per channel for buildings larger than 100,000 sqft and 0.5W for buildings smaller than 100,000 sqft
6. Channelized uplink (AGC): required.
7. Channelized uplink squelch support: required.
8. Web base interface and support for SNMP traps (v. 2 and v.3): required.
9. Built-in Isolation test: Required.
10. Dry contacts for alarms per NFPA 1221: required.
11. Basis of design: Comba Telecom, Solid or approved equal

G. Universal Multiband, Multi-service software based repeater platform (Node). This unit provides digital programmable filtering to select the signals that will be propagated in the DAS system. This unit shall be manageable and have the ability to transmit SNMP alarms. This unit shall be modular and shall be provided with the proper cards for covering all frequencies listed in this specification.

1. Approved Manufacturer: Harris, Solid, Commscope or Approved equal.

H. Base Station Interface Unit (BIU). For the downlink path, the BIU shall receive simplexed signals from the RF signal source. The BIU shall independently filters, attenuates and controls each signal and transmits these to the system's Optical Distribution Units (ODU). Each BIU shall consists of up to two MDBUs (SISO chassis) or up to two MDBUs (MIMO chassis) and can support up to nine or 17 discrete inputs per sector, respectively (four per MDBU and one V/UHF combined input on the BIU chassis). Supported bands include VHF, UHF, 700MHz, 800MHz, 850MHz, 900MHz, 1900MHz, 2100MHz, and 2500MHz TDD. This BIU shall be classified as a Class A system.

1. Approved Manufacturers: Harris, Solid, Commscope or Approved equal

I. Optical Distribution Unit (ODU). This unit shall convert all RF signals to a fiber optics signal for transmit and receive to the different Main Remote Units (MRU).

1. Approved Manufacturers: Harris, Solid, Commscope or Approved equal

J. Fiber Remote Units (FRU). The FRU shall convert the optical signals back to RF signals and transports them across coaxial cable to the DAS omnidirectional antennae

which radiate the wireless signals within the corresponding sector to the user equipment. For the uplink, the signal follows the reverse path using the same equipment. The units shall provide monitoring status for code compliant.

1. Approved Manufacturers: Harris, Solid, Commscope or Approved equal

K. DAS Management System (DMS). The DAS Management System shall be a network management device that provides remote control and monitoring of the DAS through a standard Internet connection.

1. Approved Manufacturers: Harris, Solid, Commscope or Approved equal

L. DAS Annunciator and Monitoring Panel: The Das system shall include a DAS annunciator and monitoring panel as required by code. The specifications of this unit shall be:

1. It shall include a rechargeable battery to provide 24 hours of backup power.
2. The unit shall include built in LED indicators to notify the different alarms.
3. The unit shall provide status indicating for the following elements of the DAS system

    a. The BDA
    b. The donor Antenna
    c. AC power
    d. Battery Capacity
    e. Battery Charger
    f. System Status

4. The unit shall include Form-C relay contact for interfacing to a fire alarm panel, for all signal inputs.
5. The unit shall be housing in a NEMA-4 enclosure and capable of monitoring the communications link for integrity.
6. If the BDA does not offer an output for monitoring the donor antenna, the system shall be provided with a bias-T fitting in the donor antenna cable to monitor the status of the donor antennas.
7. Basis of design: DAS alert Model 1221A

2.2 RACEWAYS FOR DAS SYSTEM

A. All raceways for the DAS shall have a survivability level 1, as defined in NFPA 72 and as required by the AHJ.

B. All equipment for the DAS system shall be installed inside a NEMA 4 metallic enclosure. For the head end system, use an outdoor rated free standing cabinet. For smaller equipment, use a wall mounted enclosure (no less than 36” X36”X8”) with a hinged door and lock. All enclosures and cabinet shall be painted red and shall include a label indicating it is Fire Department Equipment and the name of the company who supports the system and contact information.

2.3 POWER BACKUP

A. All DAS equipment shall be powered through emergency power branch circuit and shall be feed through a UPS system with a 12 hours of battery backup. The RFS installer shall estimate the required capacity of the UPS and the required battery backup. The UPS selected for this system shall have a monitoring card using dry contact relays to notify the faults, so they can be supervised.

B. Because of code requirements to house DAS equipment in NEMA 4X enclosure, the Uninterrupted Power Supply (UPS) system used to power the DAS system shall be based in outdoor rated UPS. The UPS system shall have monitoring capabilities through dry contact relays. Basis of Design Alpha Micro (Outdoor UPS units) with monitoring card or approved equal.

2.4 SUPERVISION OF DAS SYSTEM

A. All DAS equipment shall be supervised as required by NFPA 1221. The monitoring shall happen through the fire alarm system and a dedicated remote annunciation panel located in the fire command room.

B. The scope of work for the monitoring shall be, not only for the head end but also for all the fiber remotes and the UPS units providing power to all components of the system.

C. The monitoring if the system shall happen through the Fire Alarm System (FAS), by means of monitoring modules connected to the DAS annunciator and monitoring panels. The FAS shall have a dedicated annunciator panel for the DAS system located at the main entrance to the building or inside the Fire Command Room.

2.5 IDENTIFICATION AND LABELING TAGS

A. The RFS installer shall follow labeling materials indicated in specification section 27 00 10

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: The RFS installer shall follow all installation practices indicated in specification section 27 00 10.
B. The RFS installer shall design, install, commission and test the DAS in accordance with the manufacturer’s instructions and recommendations.
C. All FODCs for fiber the optics cables feeding the DAS system shall be installed inside the NEMA 4X enclosures or cabinets holding the DAS equipment.

3.2 PERFORMANCE REQUIREMENTS

A. The PSN DAS shall comply with NFPA-72 and NFPA 1221.

B. Installers shall state the assumed channel count for the PSN Frequency Bands identified above in Section 1.3. with submittal of bid response. Prior to installation, installers shall confirm the channel count and frequencies with the AHJ, and shall guarantee coverage for these channels per the criteria stated above.

3.3 SYSTEM WARRANTY AND SERVICE

A. General: The RFS installer shall follow all warranty and service requirements indicated in specification section 270010.

B. All Fiber optics cabling for the DAS system shall be covered in the same warranty for the structured cabling system indicated in specification section 27 10 00.

3.4 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The RFS installer shall follow all test requirements indicated in specification section 27 00 10.

B. Additional testing requirements for the RF system:

1. All antenna feed lines shall be RF swept with TDR to determine proper installation without kinks or damage to the coax

3.5 TRAINING AND INSTRUCTION

A. General: The RFS installer shall follow all training requirements indicated in specification section 27 00 10.

3.6 AS BUILT DOUCMENTS AND CLOSE OUT INFORMATION

A. General: The RFS installer shall follow all as built and close out information requirements indicated in specification section 27 00 10.

B. Additional requirements for as built documentation shall include:

1. Donor antenna, grounding and lighting protection details
2. Cable routing, splitters, couplers and coverage antenna locations
3. Active component locations, layout and configuration
4. Test Reports. PSN: Submit Accepted ATP reports confirming the requirements of part 3 of this specification.
5. Field Reports: Submit sweep-testing results for all cable runs.

6. Field Reports: Submit OTDR test results for all fiber runs.
7. Copy of the signed agreement for frequency re-broadcast between owner and PSN FRSE.

END OF SECTION 28 05 37

SECTION 28 10 00 - ELECTRONIC SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The scope of work shall include furnishing all labor, materials, enclosures, wiring, equipment, programming, training, testing, documentation and warranty support, required to provide a completely operational and working Security System.

B. The Security System Installer (SSI) shall coordinate with the door frame installer, the door installer, the door hardware installer, and gate installers on the placement of all electronic locking hardware and door controls for this project. The SSI shall provide the low voltage power supplies for all electric locks, wire and cable, terminate all connections, and shall interface this equipment with the integrated security system.

C. All materials for the structured cabling system (4-pair UTP cables, fiber optic cables, and 24-AWG multi-pair (25 pairs or higher) components required for the security system shall be in compliance with specification Section 27 10 00.

D. The scope of work for this specification also include the following items:
   1. The supply, installation, and programming of the Video Intercom system.
   2. The supply, installation, and programming of the Emergency/Assistance call station.
   3. The programming of the access control software including the integration described in this specification section.

E. The following parts of the system are not part of this contract:
   1. All networking equipment (switches, routers, etc) for the operation of the system
   2. All computers and software to run the security system with the exception of the items indicated in this specification.
   3. Software licenses for the security system beyond the 12 months included in this contract.

1.2 RELATED DOCUMENTS

A. General Terms and Conditions of the Contract Documents
   1. Division 8 – Door Hardware
   2. Division 26 – Electrical

B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 27 00 10 Technology General Provisions
   2. 27 05 28 Raceways for Technology
   3. 27 10 00 Structured Cabling System
   4. 27 05 26 Grounding and Bonding for Communication Systems

5. 28 20 00 Video Surveillance System

1.3 SECURITY SYSTEM INSTALLER QUALIFICATIONS

A. The SSI selected for this project must be a direct manufacturer authorized representative of the product they propose to provide. All technicians assigned to install and configure this system shall be factory trained and certified for the proper installation of this equipment. The SSI must have a minimum of 5 qualified and factory trained technicians to support this system. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years. This company shall have a fully staffed office of sales and technical support representatives within 100 miles of travel to this project.

B. Other required SSI qualifications are:
   1. The SSI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The SSI shall be able to perform any and all repairs to the system within 24 hours.
   2. The SSI, as a minimum, must carry a current state issued limited energy license.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

A. General: See details for alternates and substitution in specification section 27 00 10.

B. Due to compatibility issues with other buildings under the control of the owner, the only approved system to be provided in this project is Genetec. No substitutions are accepted for this type of equipment.

C. Sensors or door security devices with the exception of card readers shall allow for substitutions.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. The SSI shall follow all requirements for shop drawings indicated in specification section 27 00 10.

B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the A&E for review and approval, as part of the product/installer approval process.
   1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
   2. Product numbers, specifications, and data sheets for all equipment.
   3. Data sheets and samples of all labeling materials and equipment to be used in the project.
   4. A complete explanation of the identification method to be used for all equipment and cabling part of the security system.

5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
6. Detailed drawings of all custom products to be used in the project.
7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.

C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. Access controlled doors shall have the door name. All other devices shall have a unique identifier, as they will be programmed in the system.
2. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination. These diagrams shall be submitted for each door type and for each type of device in the system.
3. Panel schedules in a table format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all access control panels, alarm panels, fiber optics distribution frames, Ethernet switches, patch panels, termination blocks, etc.
4. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
5. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
6. Termination details for multi-conductor connectors and other details not included in item 2 of the shop drawings.
7. Outline of the testing process.
8. Training syllabus for all systems included in this scope.

1.6 ABBREVIATIONS

A. Additional abbreviations used in this document:
1. ADA - Americans with Disabilities Act
2. API - Application Programming Interface
3. ASCII - American Standard Code for Information Interchange
4. BPS - Bits Per Second
5. DIN - German Institute of Standardization
6. DPS - Door Position Switch
7. FCC - Federal Communications Commission
8. GUI - Graphical User Interface
9. ID - Identification
10. I/O - Input /Output
11. ISC: Intelligent System Controller
12. ODBC - Open Database Connectivity

13. O&M - Operations and Maintenance
14. PIN - Personal Identification Number
15. PTZ - Pan/Tilt/Zoom
16. RAID - Redundant Array of Independent Disks
17. REX - Request to Exit
18. RoHS - Restriction of Hazardous Substances Directive
19. SCS - Security Control System
20. SDRAM - Synchronized Dynamic Random Access Memory
21. STP - Shielded Twisted Pair
22. UL - Underwriters Laboratories, Inc.
23. UPS - Uninterrupted Power Supply
24. USB - Universal Serial Bus
25. UTP - Unshielded Twisted Pair
26. VOC - Volatile Organic Compounds

1.7 GLOSSARY OF TERMS

A. The following terms are defined for the purposes of this specification:
   1. Access Group: A logical group of card readers (terminals) which may be connected to one or more sub-controllers and which represent a collection of readers for which a particular cardholder may have access privileges.
   2. Access Mode: The mode of operation in which the security control system shall only annunciate tamper and trouble conditions at a monitored point. Alarm conditions shall not be annunciated in this mode. Also referred to as alarm shunting.
   3. Acknowledge: The action taken by a security control system operator to indicate that he/she is aware of a specific alarm or tamper state.
   4. Action Messages: A set of instructions automatically provided to the operator when an alarm condition is generated.
   5. Advisory: A message provided by the security control system to the operator to inform him/her of a condition as reported by the security control system.
   6. Alarm Condition: A change of state, as sensed by the security control system, indicating that the security control system has detected a condition which its sensors were designed to detect.
   7. API Integration: a method to transfer information between two systems by means of APIs, though an Ethernet communication network.
   8. Cardholder: A person who has been issued a valid access card.
   9. Card Reader: A device usually located at access points, designed to decode the information contained on or within a card key credential for the purposes of making an access decision or for identity verification.
   10. Clear: The action taken by a security control system operator to respond to an alarm condition or advisory so that other alarms may be serviced or so that other actions may be taken.
   11. Download: To send computer data from the File Server to a controller for the purposes of making access decision without the intervention of the File Server.
   12. Facility Code: A coded number, in addition to the individual card number, stored within each card key that uniquely identifies the facility at which the card is valid. This feature prevents cards from one facility from being used at another facility that has a similar access control system.

13. File Server: Primary host computer in the networked security system which maintains the access control system database.
14. Line Supervision: The monitoring of an electrical circuit via electrical and software systems to verify the electrical integrity of the supervised circuit.
15. Off-line: A condition in which a controller(s) is not in communication with the File Server. In the off-line mode, the controller continues to make access decisions and process alarms according to the information stored at its local database.
16. Password: A combination of numbers or letters unique to security control system operator which defines commands and data fields he/she may view, edit, or command.
17. Relay integration: A method to transfer signals between two systems by means of using potential free contact closures to input points.
18. Reset: A command or feedback signal that indicates that a monitored point has returned to its normal state after having transferred to the alarm or trouble state.
19. Secure Mode: The normal state of an alarm input point from which it will be monitored for change of state to either an alarm or trouble condition.
20. Secured Area: A physical location within the facility to which access is controlled by one or more card readers.
21. Secured side: Side of a security door where a higher security level needs to be granted for a user to be authorized to be in that side of the door.
22. Serial line integration: A method to transfer information between two systems by means of an RS-232/RS-422 or RS-485 line, using ASCII strings.
23. Tamper: A condition within the circuitry of a monitored point which indicates the electrical integrity of that sensing circuit has been compromised.
24. Tamper proof screws: A screw with a security hexalobular internal driving feature as described in ISO 10664. As an example, a security TORX head, as developed by Camcar LLC.
25. Time Interval: A time stamp of one start time and one stop time within a time period.
26. Time Period: A user programmable period of time made up of days of the week and hours in the day.
27. Trouble: A condition within the circuitry of a monitored point which indicates that an equipment malfunction, single break, single fault or a wire-to-wire short exists.
28. Unsecured side: Side of a security door where a lower security level needs to be granted for a user to be authorized to be in that side of the door.
29. User Definable: An attribute of a security control system function that may be easily tailored by the System Administrator.
30. Workstation: A personal computer connected to the main security control system File Server via a local area network connection for the purpose of programming the system and responding to alarms.

1.8 SYSTEM DESCRIPTION

A. The security systems primary purposes shall be to provide access control and alarm monitoring capabilities for this project. The system shall provide functionality such as the ability to regulate and control access through specific areas of the facility and fully integrate with other security components such as closed circuit television, alarm system, intercom and digital video recording.

B. The system must utilize a single seamlessly integrated relational database for all functionality. This integration shall be provided using a single operating environment. The operating environment shall be the fully multi-tasking multi-threading operating System.

C. Alarm monitoring and administrative workstations must be able to connect to, and monitor, field hardware devices such as card readers and intelligent system controllers. Administrative tasks including defining asset information, access groups, time zones, configuring digital video devices, generating reports, creating maps, etc. shall be provided from any client workstation on the network that is licensed to do so. All systems must utilize a single database on the network and must be accessible in real time to any security workstation connected to the network. This shall allow for automatic change propagation to all client workstations as well as common database consolidation.

D. A real-time graphical map representing the layout of this building shall indicate if an electronically controlled door is in a secure or unsecured mode. Control modules will be required to lock, or unlock, any electronically controlled door or vehicle gate at this facility. An automatic cardholder call-up feature shall allow for the quick search and display of images in the database. A System's Operator journal shall be available to log important daily events. A trace function shall be available for System Operator's to locate and track activity on a specific cardholder or at a specific card reader. All system hardware must be controllable using a mouse to click on the associated system icon.

E. The security system shall be designed to support an advanced distributed network architecture, whereas Intelligent System Controllers do not need to be home-run wired back to the database server. All Intelligent System Controllers shall be connected to an Ethernet network via industry standard TCP/IP communication protocol. Network based Intelligent System Controllers shall be able to communicate back with the database server through industry standard network switches and routers.

F. The security system shall support a data encryption utility. In utilizing encryption technologies, data communication shall be protected between workgroups, local area network computers, domain clients and servers, branch sites which may be physically remote, extranets, roving clients, and remote administration of computers.

PART 2 - SYSTEM CHARACTERISTICS

2.1 SECURITY SYSTEM SOFTWARE

A. The SSI shall provide all software required for the complete operation of the access control system.

B. Acceptable product for the security system software is:
   1. Genetec

C. At a minimum the security system software shall provide the following key features:

1. Ability to integrate with other system with features as indicated in this specification.
2. Be able to operate with cards with multiple system codes.
3. Have an integrated platform with the video system.
4. Support browser based clients and standard client workstation.

2.2 COMPUTER SYSTEM HARDWARE

A. Computer based system are required for the operation of the security system. The following types of computer systems are required for the system:
   1. Server: System that communicates with ISC and other hardware. It is also the system with the database of all the components and transactions of the system. Server shall be installed in a secured room.
   2. Workstation: System accessible to users for operating, configuring and accessing reports from the security system. Workstations communicate with the server through TCP/IP.
   3. Badging workstation: A system used to create the picture IDs for the system

B. INTEGRATED SERVER. When the manufacturer of the Security System Software offers the server as an integrated appliance and as a single part number, the server shall be as indicated by the manufacturer.

C. SOFTWARE ONLY. When the manufacturer of the Security System Software offers the possibility of providing the software only and the SSI is required to provide the hardware platform for the server the SSI shall provide a server in compliance with the Minimum Specifications by Software Manufacturer (MSSM) plus an extra capacity as indicated below:
   1. Processor speed: MSSM + 30%
   2. Cache memory: MSSM + 30%
   3. Front side bus speed: MSSM +30%
   4. Memory: MSSM + 100% (or maximum memory supported by Operating system)
   5. Hard drive capacity: MSSM + 100% in RAID 1 configuration
   6. CD/DVD Drive: DVD ROM Drive SATA, internal
   7. Network Card: Dual 1 GB connections
   8. Power supply: High Output Power Supply, Redundant.
   9. USB ports: Minimum six (6) USB 2.0
   10. Mounting: Rack chassis with sliding rapid/versa rails and cable management arm.
   11. Operating system: As required by security system software.
   12. Additional software: Database packages as required by Security System manufacturer. Antivirus and Internet Security package with a 1 year license
   13. Warranty: 3 –year warranty.

D. BROWSER BASED WORKSTATIONS. When the manufacturer of the security system offers browser based access to the security system, workstations will be provided by owner. Browser based workstations are only allowed in the system if they provide a complete functionality of the system. If the browser based workstation offers only a partial set of functions compared to a Client based workstations, browser based workstations will only be allowed additional to client based workstations.

2.3 INTELLIGENT SYSTEM CONTROLLER (ISC)

A. An Intelligent System Controller (ISC) shall link the security software to all other field hardware components like card readers, inputs and outputs. Controllers shall operate as autonomous, microprocessor based processing units:
   1. ISCs shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
   2. ISCs shall be part of a fully distributed processing-control network.
   3. The portion of the database associated with an ISC, and consisting of parameters, constraints, and the latest value or status of points connected to that ISC, shall be maintained in the ISC.

B. ISC can be one single hardware board or multiple hardware boards linked together. The following functions shall be fully implemented and operational within each ISC:
   1. Monitoring inputs (open, closed or fault).
   2. Controlling outputs.
   3. Automatically reporting alarms to the system server.
   4. Reporting of sensor and output status to the system server on request.
   5. Maintaining real time, automatically updated by the system server at least once a day.
   6. Communicating with the system server through a secured encrypted Ethernet TCP/IP communication.
   7. Communicating with other ISC or hardware devices through serial RS-422/RS-232/RS-45 encrypted lines.
   8. Executing ISC resident programs.
   9. Diagnosing.
   10. Downloading and uploading data to and from the system server.

C. ISC Operations at a Location:
   1. Globally operating I/O linking and anti-passback functions between ISCs within the same Location without system server or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the system server or workstations are off-line.
   2. In the event of communication failure between the system server and a Location, there shall be no degradation in operations at the ISCs at that Location. ISCs at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
   3. Buffered events shall be handled in a first-in-first-out mode of operation.

D. Individual ISC Operation:
   1. ISCs shall transmit alarms, status changes, and other data to the system server when communications circuits are operable. If communications are not available, ISCs shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the system server, shall be stored for later transmission to the system server. Storage capacity for the latest 1024 events shall be provided at each ISC.

2. Card-reader ports of an ISC shall be custom configurable for at least 120 different card-reader or keypad formats (Weigand). Multiple reader or keypad formats may be used simultaneously at different ISCs or within the same ISC.
3. ISCs shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
4. ISCs that are reset, or powered up from a non-powered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
5. Initial Startup: When ISCs are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each ISC.
6. On failure for any reason, ISCs shall perform an orderly shutdown and force ISC outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
7. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which ISCs shall resume normal operation.
8. After ISC failure, if the database and application software are no longer resident, ISCs shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, ISCs shall immediately resume operation. If not, software shall be restored automatically from the system server.

E. Communications Monitoring:
1. System shall monitor and report status of serial communications loop of each Location.
2. Communication status window shall display which ISCs are currently communicating, a total count of missed polls since midnight, and which ISC last missed a poll.
3. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each ISC.

F. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the system server at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

G. All ISCs shall be UL listed. Input points in ISCs shall be UL 294 listed.

H. Basis of Design:
1. System Controller: Mercury LP series
2. Reader Interface module: Mercury MR52
3. Sixteen (16) Input module:
4. Sixteen (16) Output module:

2.4 POWER SUPPLY/ENCLOSURES – ACCESS CONTROL SYSTEM

A. All ISCs and other boards part of the access control system shall be installed inside a metal enclosure with a power supply as recommended and designed by the manufacturer of the equipment.

B. The low voltage power supply shall convert a 115 VAC or 24 VAC 60 Hz input to a continuously supplied current of 12 or 24 VDC. The power supply shall be UL listed, fused protected and class 2 rated.

C. The power supply shall include a battery charger to provide backup power when main power goes down. If ISC has a battery charger and input built in, then the power supply does not need this feature.

D. Plug in transformers feeding a low voltage power supply feeding an access control panel are not allowed unless they are mounted inside another lockable enclosure. External multi-output individually fused protected outputs power supplies feeding all access control board are acceptable as long as they are located next to the access control panels.

E. Maintenance free batteries shall be provided with all power supplies or ISC and shall be mounted inside the same enclosure. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.

F. All enclosures for ISCs, other electronic boards, power supplies or battery cabinets shall be UL listed NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4X enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.

G. Basis of design: LifeSafety Power FPO150/250-2D8P2M8NL4E8M2

2.5 TAMPER SWITCH

A. All security enclosures, including power supplies and terminal cabinets shall include a tamper switch for direct supervision of the cabinet door. Any opening of these doors shall initiate an alarm condition to the security monitoring system. All tamper contacts shall be a reed actuated self adjusting plunger style switch. If a tamper contact is provided by the manufacturer with the enclosure this device may be used.

B. Tamper switches shall be wired as to report separate alarms to the system for each panel.

C. Basis of design: Amseco PSW-1 or an approved equal.

2.6 CONTACTLESS SMART CARD READER

A. The standard smart card reader for use throughout this facility shall be a switchplate style reader in low profile weatherized polycarbonate housing suitable for mounting in either an indoor or outdoor environment. The reader shall be constructed of a polycarbonate material sealed to a NEMA rating of 4X IP65. The reader shall contain an integral magnet for use with an external magnetic reed switch to provide tamper protection when connected to an external alarm. The reader shall be UL/C 294 listed and shall conform to FCC and ISO standards. The reader shall operate at a frequency of 13.56MHz. All RF data transmitted between this device and the smart card shall be encrypted for additional protection using a secure algorithm. The reader shall provide an audiovisual indication to signify access granted or access denied. This operation shall be displayed by a high intensity LED light bar which shall change from red, amber, or green based on the status of the operation. The housing shall mount on an industry standard single gang electrical junction box. It shall have a read range of 4.0 to 4.5 inches when used with a standard smart access card and 1.0 to 2.0 inches when used with a key tag.

B. The mullion style readers shall only be used where wall mounting is not possible (for example glass/aluminum store-front systems).

C. The smart card reader with keypad shall have a standard contactless smart card and shall have a twelve (12) key keypad. Readers with keypad shall be used where indicated in design drawings.

D. With every badging station provided for this project, a verification reader with keypad shall be provided. This reader shall also have writing capabilities to the access cards. This reader shall be provided with USB interface and a stand for desktop mount.

E. Communications between the readers and the ISC shall be through a Wiegand interface

F. Basis of design selection: HID i-Class SE series.

2.7 CONTACTLESS SMART CARD

A. The contactless smart cards for the access control system shall be receptive to a standard smart card reader. Body shielding or variable environmental conditions shall have no adverse effect on their operation. The card shall be a read only type device

B. All cards ordered for this project shall have the same system code.

C. All read/write cards ordered for this project shall have a 16K bit dual application area.

D. All access cards or tags shall be purchased through the HID Corporate 1000 program with the facility code assigned to the owner.

E. Basis of Design: HID i-Class SE

2.8 LOCKING DEVICES – SPEICIFED UNDER DIV 8

A. The SSI shall coordinate with the door hardware installer on the placement of electronic locking hardware required for this project. The SSI shall provide all necessary wire and cable, and the low voltage power supplies for door locks. The SSI shall also be responsible for terminating all connections and interface this equipment with the integrated security system.

2.9 DELAYED EGRESS ELECTROMAGNETIC LOCKS

A. The delayed egress electromagnetic locks for this project shall be a NFPA 101 compliant units with a holding force of 1,500 lbs. The unit shall be able to be powered from a 12VDC or a 24 VDC power supply.

B. The delayed egress electromagnetic lock shall have the following options at a minimum: Bypass monitor, door status switch, and dynastat force sensor.

C. Accessories: The SSI shall provide all accessories for proper mounting of the delayed egress electromagnetic lock to the door frame such as filler plates, Z-brackets, or angle brackets.

2.10 ELECTROMAGNETIC LOCKS

A. The electromagnetic locks for this project shall provide a locking force of 1,500 lb. The unit shall be able to be powered from a 12VDC or a 24 VDC power supply.

B. The electromagnetic lock shall have the following options at a minimum: bi-color LED indicator and door status switch.

C. Accessories. The SSI shall provide all accessories for proper mounting of the electromagnetic lock to the door frame such as filler plates, Z-brackets, or angle brackets

2.11 DOOR RELASE BUTTONS (REQUEST TO EXIT SWITCH/BUTTON)

A. Where indicated on the drawings, a door release button shall be provided to function as a secondary method of door release on locked doors. The door release button shall have the following specifications:
   1. Button type: Illuminated.
   2. Button size: two inches square
   3. Lettering: “Push to Exit”
   4. Box size: Single gang
   5. Contacts: Momentary DPDT or (1 SPST N/O and 1 SPST N/C) 5A @ 30 VDC
   6. Built-in timer: Pneumatic timer, only required when used with electromagnetic locks.
   7. Finish: Bright Chrome
   8. Basis of design: RCI 991-PTD or equal.

B. For applications where the door release buttons will be located under a desk a rocker switch shall be used instead of the regular exit device. The design selection for the rocker switch is the RCI 909 surface mounted.

2.12 REQUEST TO EXIT EGRESS MOTION SENSOR

A. The egress sensors shall utilize passive infrared technology to detect the motion of individuals approaching a door. Upon activation this device shall release the lock, and shunt the magnetic door position switch to allow unobstructed egress through the door. This device shall be field adjustable to fit the monitoring requirements of the location where installed.

B. All request to exit motion sensors shall be provided with a trim plate for mounting the detector over a standard single gang junction box.

C. Basis of design: Detection Systems/Bosch model DS150i or an approved equal

2.13 MAGNETIC DOOR POSITION SWITCH – DPS

A. The standard recessed door position switch shall be Interlogix 1078 series or approved equal. The contact and the magnet shall be hermetically sealed in a one piece, molded, flame retardant ABS plastic housing for maximum strength and durability. The contact and magnet shall snap-lock into a predrilled 3/4” or 1” diameter hole. Color of the housing shall be off white, gray, or mahogany, and shall be provided in the appropriate color to match the door and doorframe. The magnet shall be made of Alnico V.

B. The standard position switch for a roll up door shall be an Interlogix 2207AH high security contact or approved equal.

C. On banks of doors where multiple doors are being monitored, door contacts shall be wired in series. All double doors shall receive (1) magnetic door position switch on each door leaf and shall report as one alarm point.

D. On exterior doors with impact resistant listings, use only surface mounted door position switches in lieu of the standard recessed door position switches. The design selection is the Interlogix 1085T or approved equal.

2.14 DURESS PANIC BUTTON – UNDER DESK

A. The unit shall consist of a housing that contains the electrical circuitry and magnetic reed contact, a cover plate to protect the internal electronics and actuating lever with an Alnico-V magnet installed in the cradle lever. The alarm shall occur when the actuating lever is moved 20 to 45 degrees past the fully closed position. The unit shall feature a glowing LED for low light visibility, when powered up this shall be lighted green, when activated this light shall glow red. The unit shall be mounted in specific

locations of rooms indicated on the drawings. Obtain client approval on these locations prior to locating these devices.

B. Basis of design: Interlogix 3040 series panic switch or an approved equal.

2.15 SURGE PROTECTION

A. All security components mounted outside the building and wired through low voltage copper conductor back to the building shall be provided with surge and lighting protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equal. For RS-485 or RS-422 connections provide PC642C-008LC with base PCB1B manufactured by EDCO or an approved equal.

B. For exposed Ethernet connections with PoE, use EDCO CAT6-E PoE or approved equal.

2.16 POWER SUPPLY – DOOR LOCKING HARDWARE AND SENSORS

A. Power supplies for door locks or powered sensors (i.e. request to exit motion sensors) shall be completely separate from power supplies for ISC or electronic hardware part of the card access system.

B. The power supply for door locks and powered sensors shall convert a 115 VAC 60 Hz input to a continuously supplied current of 24 VDC. The power supply shall be UL listed, NFPA compliant, and have multiple class 2 rated outputs. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4 enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.

C. The power supply for door locks and powered sensors shall include a battery charger and a battery input to provide power to the locks after a main power system failure. The switchover to stand-by battery shall be automatic when main AC power fails.

D. Power supplies for regular locking hardware shall be installed next to access control panels.

E. Maintenance free batteries shall be provided with all power supplies. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.

F. The power supply for door locks and powered sensors shall have the following features:
   1. Number of outputs: 16 programmable as fail-safe or fail secure individually

2. Fire alarm disconnect: Yes, latching or unlatching and individually selectable for any of the inputs.
3. Output protection: PTC
4. Monitoring: AC fail and low battery with dry contact closure.

G. Basis of design: Altronix Maximal series.

2.17 KEY SWITCH

A. The key switch shall be capable of fitting in a dual gang box with a single device adapter. The specifications of the key switch are:
1. Plate construction: ¼" extruded aluminum plate
2. Switch mode operation: maintained action.
3. Switch configuration: one SPDT and one DPDT
4. Cylinder: Match owner's keying standard.
5. Screws: tamper resistant.
6. LED: bi-color (red-green) mounted in plate.
7. Design selection: Rutherford controls International model 960 or similar.

2.18 EXTERIOR EQUIPMENT HOUSING

A. NEMA 4X rated 316L stainless steel enclosures shall be provided to house electronic security equipment to all vehicle gates. The enclosure shall have dimensions as required to hold electronics.

B. All enclosures shall be provided with a pad lock and a tamper switch for direct supervision. Any door opening shall initiate an alarm condition to the security monitoring system. All cores shall be keyed alike. A grounding package shall be provided for connection to a ground rod. A #8 solid copper ground wire shall be provided and installed from the ground lug to a grounding rod installed next to the enclosure.

C. All exterior enclosures shall include a compact air condition unit. The air condition unit shall be as indicated in the design drawings. All air condition units shall be monitored for proper operation through relay contacts through the access control system.

D. Basis of design: nVent Watershed, Type 4X

2.19 WIRE & CABLE

A. Cables for un-powered security sensors shall have the following specification:
1. Minimum cable gauge: AWG 20
2. Number of conductors: 2, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black and red.
6. Voltage rating: 300V

7. Cable shield: No cable shields

B. Cables for powered security sensors shall have the following specifications:
   1. Minimum cable gauge: AWG 20
   2. Number of conductors: 4, stranded conductors
   3. Conductor type: Bare copper
   4. Cable insulation: Color coded PVC
   5. Conductor insulation colors: Black, red, white and green.
   6. Voltage rating: 300V
   7. Cable shield: No cable shields

C. Cables for access control readers shall have the following specifications:
   1. Minimum cable gauge: AWG 22
   2. Number of conductors: 6, stranded conductors
   3. Conductor type: Tinned copper
   4. Cable insulation: Color coded PVC
   5. Conductor insulation colors: Black, red, white, green, orange (or brown) and blue.
   6. Voltage rating: 300V
   7. Cable shield: Aluminum/polyester foil (overall) with a AWG 24 tinned copper drain wire

D. Cables for RS-232, RS-422 or RS-485 control lines shall have the following specifications:
   1. Minimum cable gauge: AWG 24
   2. Number of conductors: 2-paired, stranded conductors
   3. Conductor type: Tinned copper
   4. Cable insulation: Polyethylene
   5. Conductor insulation colors: White-blue, blue-white white-orange and orange-white
   6. Voltage rating: 300V
   7. Cable shield: Aluminum/polyester foil (overall), a tinned copper braid (90% coverage) and a AWG 24 tinned copper drain wire
   8. Nominal characteristic impedance: 120 Ohms
   9. Nominal capacitance: 12.8 pF/ft.
   10. Nominal delay: 1.6 ns/ft.
   11. Nominal attenuation: 0.6 dB/100 ft @ 1 MHz.

E. Cables for door locks and low voltage power supplies shall have the following specifications:
   1. Minimum cable gauge: AWG 18
   2. Number of conductors: 2, stranded conductors
   3. Conductor type: Bare copper
   4. Cable insulation: PVC
   5. Conductor insulation colors: Black and red.
   6. Voltage rating: 300V
   7. Cable shield: No cable shields

F. Cables for loop detectors shall have the following specifications:
   1. Minimum cable gauge: AWG 16

2. Number of conductors: 1, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Cross-linked polyethylene (XLPE)
5. Conductor insulation colors: Black
6. Voltage rating: 600V
7. Cable shield: No cable shields

G. All UTP Category horizontal cables and fiber optic cables for the security system shall be in compliance of all requirements in specification section 27 10 00 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 27 10 00.

H. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The SSI shall always estimate proper values.

I. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits. All spaces above ceilings in this project shall be treated as plenum spaces. All cables with a NEC type TC shall be run fully in conduit from the panel to the device and shall be separated from other communication or Class 2 rated cables.

J. Cable jackets for this project: Except when cables are run continuously in conduit all cable jackets for access control cables shall be plenum rated.

K. All cables shall be RoHS compliant and free of VOC. The SSI shall provide proof of compliance for all cables during the submittal process.

L. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.20 IDENTIFICATION AND LABELING TAGS

A. The SSI shall follow labeling materials indicated in specification section 27 00 10

PART 3 - EXECUTION

3.1 SECURITY SYSTEM INTEGRATION

A. General: A. The access control system software shall integrate with the other security system components as indicated in this section. The SSI shall be responsible for programming all security systems in such a way that interaction between the different systems is achieved to provide a higher degree of security in the building. The minimum required integration features between the access control and the other security systems are described below:

B. ACCESS CONTROL AND DIGITAL VIDEO RECORDING SYSTEM

1. The Access control software proposed shall integrate with the new Digital Video Recording System (DVRS) proposed for this project (refer to specification section 28 20 00 for details on the Digital Video Recording System). The integration shall make the following features possible from the Access Control GUI:
    a. Event video tagging. Selectable security events in the access control system shall tag the recorded video, so when the operator reviews the event, video from that moment in time when the event took place shall be retrieved automatically and brought into a window of the access control GUI.
    b. DVRS playback control: Through the access control GUI, the operator shall be capable of controlling the video playback. The operator shall be capable of retrieving any recorded video from any camera by using a time search or an event search. The operator shall be capable of controlling the speed of the playback by selecting frame by frame playback or playback at higher speeds.
    c. Live video: The operator shall be capable of displaying live video in window in the access control GUI. The operator shall be capable of selecting the camera in the system that he/she wants to see. Up to 4 live video windows (live or recorded) shall be possible in every workstation running the access control GUI.
    d. PTZ Control: The operator shall be capable of controlling all PTZ features of a camera by simply using buttons in the Access Control screen with the orientation of movement.
    e. Alarm event: Any alarm event (like video analytic alarms, or video motion detection) in the DVRS shall be transferred to the access control system for processing as any other alarm in the access control system. Alarms shall be uniquely identified in the access control system.
    f. Status events: Any status events (system errors, or administration events) in the DVRS shall be transferred to the access control system for processing as any other status event in the access control system. Events shall be uniquely identified in the access control system.
    g. Export/load video file: the operator shall be able to export or load video files compatible with the recording format of the DVRS from the access control GUI.
    h. Recorder authentication: Since login is required for most DVRS, the login action on the Access Control System shall also grant access to the DVRS. Separate or further login to the DVRS shall not be required.
    i. Dry contact control: The operator shall be capable of triggering relay contacts part of the DVRS equipment from the access control GUI.
    j. Video locking: The operator shall be capable of locking video on the DVRS to prevent it from being purged accidentally. Locked video can be set to automatically purge or archive based on user defined thresholds.

C. CCTV SYSTEM

1. Activation of access control system alarms (like door held open, door forced open, stolen/lost card used, duress alarm, alarms coming from other systems, etc) shall call presets in the nearest CCTV cameras (one or more) to point towards the device that is in alarm. This action shall take place without any operator’s intervention.

2. Activation of access control system alarms shall call any associated camera to the triggered alarm to the operator's workstation alarm monitor. This action shall take place without any operator's intervention. When the alarm is cleared by the operator the image of the alarm monitor shall be removed. Alarms from doors in detention areas shall be received in the monitors in Master Control Room, alarms from doors in other areas shall be received in Building control room.
3. Video loss alarm: loos of video signal on any of the surveillance cameras in the system shall trigger an alarm in the access control system.
4. Graphic substation calling: Intercom substations shall be represented with graphic icons in the graphic maps part of the Access control system GUI. Double clicking on those icons shall automatically create a call to that substation from the master station associated with the user workstation initiating the command.
5. Graphic camera calling: Surveillance cameras shall be represented with graphic icons in the graphic maps part of the Access control system GUI. Double clicking on those icons shall automatically open a video window with a live stream from that camera.

D. INTERCOM SYSTEM
1. Alarm event: Activation of an intercom substation (or code blue assistance station) shall be treated as an access control alarm event, calling camera presets and calling any associated cameras to the operator's alarm monitors. This action shall take place without any operator's intervention. Substations in detention areas shall generate those alarms in Master Control room while substations in building exterior or elevators (except the prisoner elevator) shall generate those alarms in Building control room.
2. Automatic call: Alarms from doors with intercom substations installed by the door shall generate an automatic call to the master station in the monitoring rooms from the substation. The call shall be placed to the same master station that the substation is programmed to call when user pushes the call button.
3. Remote door release: During a call from a substation by an access controlled door to a master station, the user in the master station side shall be capable of opening the door by pressing a key in the mater station keypad. This action shall not create any alarm conditions in the access control system.
4. Graphic substation calling: Intercom substations shall be represented with graphic icons in the graphic maps part of the access control system GUI. Double clicking on those icons shall automatically create a call to that substation from the master station associated with the user workstation initiating the command.
5. Graphic status: intercom substations in use in the system shall be represented with a different color (red) from stations not used (green) in the graphic maps part of the access control system GUI.

E. DOOR ENTRY SYSTEM
1. Remote door release: During a call from a substation by an access controlled door to a master station, the user in the master station side shall be capable of opening the door by pressing a key in the mater station keypad. This action shall not create any alarm conditions in the access control system.

F. ALARM SYSTEM.
1. Alarm events: Activation of a device in the alarm system shall be treated as an access control alarm event, calling camera presets, calling any associated

cameras to the operator's alarm monitors and creating automatic intercom calls (if available). This action shall take place without any operator's intervention.

2. Status events: Status alarm conditions (faults or errors) shall be reported to the access control system with unique identifiers.
3. Graphic status: All alarm devices shall be represented with graphic icons in the graphic maps part of the access control system GUI. Alarm devices shall represent their status with a different color, red for "on alarm" condition, and green for "no alarm" condition in the graphic maps.

G. Different methods of integration are allowed between the access control system and the other systems. Integration methods are given different hierarchy as follows, relay integration is lowest hierarchy, serial line integration is considered medium hierarchy integration and API integration is considered high hierarchy integration. At a minimum integration between the different security system shall be provided with the integration method explained below. It is acceptable for the SSI to propose integration methods with higher hierarchy integration methods, but not with lower hierarchy methods. The requested integration methods with each system are as follows:
   1. Access control system and DVRS API integration.
   2. Access control system and CCTV system API integration.
   3. Access control system and Intercom system API integration.
   4. Access control and door entry system Relay integration
   5. Access control and Alarm system API integration
   6. Access control and Detention system Relay integration
   7. Access control and Paging system Serial line integration or API.
   8. Access control and AV systemSerial line integration or API.

3.2 INSTALLATION PRACTICES

A. General: The SSI shall follow all installation practices indicated in specification section 27 00 10.

B. Access control panels and multi-output power supplies shall be installed as to have in any cluster of panels no less than 2 spare ports (reader ports for access control) available per cluster of panels.

C. All power supplies shall be monitored for AC failure. When power supply provides a form c relay with low battery signaling, this contact shall also be monitored. All AC fail and battery low alarms shall be monitored through individual alarm inputs. Series connections of multiple alarm points shall not be allowed.

D. All buzzers inside card readers shall be wired as to function to alert users of different door status like (door held open alarm and door forced open alarm).

E. All local alarms shall be wired with separate wires for the buzzer and for the strobe, so independent use of the strobe and buzzer can be selected by the user.

3.3 WIRING METHODS

A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.

B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.

C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.

D. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.

E. All cable with gauges larger or equal to AWG-18 and all types of stranded conductors shall be terminated on termination blocks part of an active equipment or in termination blocks supplied by the SSI. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.

F. All termination blocks shall always be mount inside a security enclosure, with a hinged cover and lock. Up to 2 conductors can be terminated in the same point in a termination block as long as the combined diameter of the conductors does not exceed the maximum cable diameter allowed by the termination block. No more than 2 conductors shall be terminated in the same point at a termination block regardless of the cable gauges.

G. Termination blocks shall be used for wire terminations next to access control panels or for termination above the security doors. Termination blocks are not required for connection to security devices at the door side.

H. When equipment supplied has wire leads instead of termination en points for connections, the only acceptable methods of connection to field wiring are insulated butt splices, quick release connectors (both ends provided) or quick lock self stripping pig tail connectors. All connectors or splices shall be selected according to the gauge of the cable to be terminated.

I. All penetrations through fire rated barriers shall be provided, by the SSI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.

J. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.

K. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY-Raps" (Thomas & Betts or equal).

L. All cables run part of the security system in areas where ceiling is not accessible or in building exterior shall be in conduit at all times.

M. All cables for security equipment shall be installed in conduit to the nearest accessible ceiling space, J-hook to the cable tray and from the cable tray and from the tray to the equipment cabinets. The SSI shall provide all j-hooks to support the cables part of these components.

N. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.

O. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.

P. Finger duct wire managers shall be used inside all equipment panels to properly dress cables.

3.4 IDENTIFICATION AND TAGGING

A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by pre-printed labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. All cables shall be labeled at both ends of the cable with the same and unique identifier label.

B. Cable and equipment identifiers shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the SSI shall be submitted for approval to the A&E.

C. All access control panels, alarm panels, PLCs, or Intercom exchanges shall include a work sheet attached to the interior of the panel/ equipment in plastic envelops. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

3.5 SECURITY SYSTEM PROGRAMMING

A. Programming: It is the responsibility of the SSI to program all requested features in the access control system and the integration to other security systems. The programming responsibilities of the SSI include but not limited to:
   1. Program all security doors to achieve the desired operation as described in this specification section. The SSI shall coordinate with the owner the door names and numbers, building names, room names and numbers to be used for the programming.
   2. Program all components of the system to achieve the functionality described in this specification.

3. Program at least 5 access profiles for card holders and all access profiles for doors.
4. Create at least 5 administrator profiles. The owner will program any additional card holder profiles required in the system.
5. Program at least twenty five (25) users in the system. The SSI shall get this information from the owner. The owner will program all other users in the system.
6. Program all required security features like macros and integration with other security modules like intercom and CCTV system.
7. Program all interfaces with the elevator control systems.
8. Program all GUIs in the system. The SSI shall use AutoCAD drawings to create all maps of the facility with the corresponding icons for control, operation and visualization of the security system. The SSI shall chose a scale for the drawings that allows all icons to be places without overlap and close enough to the actual physical location of the equipment in the map as to avoid ambiguity of the actual location of the devices. Nested maps shall be programmed to go from a complete building view to a detail zoned identifying all devices in the area.
9. The SSI shall coordinate with the owner what alarms from the access control system are to be considered major alarms. All major alarms shall be programmed by the SSI to provide the operator detail information on the type of operating procedure expected during those alarms. All mayor alarms shall be programmed as to provide the operator and input field to type the response taken by the operator.
10. All programming of remote monitoring features for the security system like telephone numbers to dial, reporting codes and alarm formats.
11. All alarm messages and descriptive text of those messages shall be programmed.

B. DOOR INTERLOCKS: When indicated in the drawings (or in the sally port) two doors that have a controlled door interlocks, the SSI shall program the security system as to provide the following functionality: While one door is opened the other door shall not be possible to be opened not by using a valid transaction at the reader neither by issuing a remote release command from the access control system.

C. The SSI shall work with the owner during the programming of the system to fine tune all programming requirements of the system, as per owner's request. Fine tune is defined for this purpose as changing all field parameters available in the system, as specified, to complete software options available in the system. Fine tuning does not indicate adding additional software modules or additional hardware.

3.6 ADDITIONAL INSTALLER RESPONSIBILITIES

A. Upon project commencement, the SSI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.

B. During the installation process the SSI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process

when evaluating payment request applications. At a minimum, the drawings should contain the following information:

1. Quantity and location of all equipment installed.
2. Cable and wire runs along with the designations tags assigned to each.
3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.

C. The SSI Project Manager shall maintain continuous coordination with the A&E. The A&E shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the SSI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

3.7 REQUEST OF IP ADRESSES

A. The SSI shall comply with all requirements indicated in specification section 270010 for requesting IP address for the security system.

3.8 SYSTEM WARRANTY AND SERVICE

A. General: The SSI shall follow all warranty and service requirements indicated in specification section 27 00 10.

3.9 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The SSI shall follow all test requirements indicated in specification section 27 00 10.

B. Additional requirements for the system acceptance test:

1. The day of the final acceptance test the SSI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, SSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
3. During the final acceptance test every single device in the security system will be tested for normal operation and for simulated alarm conditions at both ends (the field devices and in the monitoring room). When possible, security equipment will be tested for operation during main power failure. All features requested in this specification will be tested.

C. Testing of all structured cabling system part of the Security System shall be done in accordance of specification section 27 10 00

3.10 TRAINING AND INSTRUCTION

A. General: The SSI shall follow all training requirements indicated in specification section 27 00 10.

B. The SSI shall provide three (3) levels of training for this project as explained in this section.

C. USER TRAINING.
1. User training shall be provided for security personnel interacting with the security system in areas different from the security monitoring rooms. The purpose of this training is to explain clearly how the field devices operate and what the different status indicators mean.
2. This training shall cover operation of devices and doors like:
   a. Operation and indication of all types of readers in the project
   b. Operation of all roll-up doors.
   c. Operation of all vehicular gates.
   d. Resetting door alarms (local) for all door types.
   e. Resetting of duress alarm buttons.
   f. Operation of door interlocks
   g. Operation of the duress alarm notification system
3. This training shall be provided by personnel working directly for the SSI.
4. At least 4 separate sessions (on 4 different days) of this type of training shall be provided (one session video-taped only).
5. Each session could have up to 20 trainees.
6. No training material is expected to be provided

D. OPERATOR/ADMINISTRATION TRAINING.
1. Operator/Administration training shall be provided for security and IT personnel interacting with the security system in all security monitoring rooms. The purpose of this training is to explain clearly how the complete system operates and what the different status indicators mean.
2. This training shall cover at least the following topics:
   a. All content provided during the user training.
   b. Operation of the Access control software (all aspects).
   c. Operation of all devices inside the security monitoring room.
   d. Alarm response and alarm reset in the security monitoring room
   e. Data backup/restore and achieving.
   f. File import/export.
   g. Badging system operation (complete description)
   h. Creating reports and print outs.
   i. Basic system troubleshooting.
   j. Creating users and password reset.
3. This training shall be provided by personnel working directly for the SSI or a direct employee of the manufacturer of the system.
4. One session of this type of training shall be provided and video-taped. This session shall last no less than 24 hours, broken down into day sessions no longer than 6 hours each.
5. Each session could have up to 20 trainees.
6. The approved O&M manuals shall be available at the time of the training.

E. MAINTENANCE TRAINING.
1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
2. This training shall cover at least the following topics:
a. Trouble shooting and replacement of all field devices.
b. Installation of all field panels and settings (jumpers, dip switches, etc).
c. Wire labeling system.
d. Software system installation and recover from system crashes.
e. Detail explanation on all physical keys used in security devices.
f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
g. Detail explanation of source code programming for all devices that have software code specifically compiled for this project.
3. This training shall be provided by personnel working directly for the SSI or a direct employee of the manufacturer of the system.
4. One session of this type of training shall be provided and video-taped. This session shall last no less than 18 hours, broken down into day sessions no longer than 6 hours each.
5. Each session could have up to 5 trainees.
6. The approved O&M manuals shall be available at the time of the training.

3.11 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION.

A. General: The SSI shall follow all as built and close out information requirements indicated in specification section 27 00 10

B. Additional requirements for as-built documentation shall include:
1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.

C. Close out information shall also include:
1. Two (2) digital backups of all configuration files and databases part of the security system not earlier than the day after the final acceptance test is approved. These backups shall include a list of all the file names used and a complete description of the system that each file name belong to. The media for these backups shall be a compatible media that can be read by the computer system running the specific software program.
2. Testing reports for structured cabling system used for the Security system.

END OF SECTION 28 10 00

SECTION 28 20 00 - CLOSED CIRCUIT TELEVISION/VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The scope of work shall include furnishing all labor, all security video cameras, pan/tilt/zoom (PTZ) cameras, mounts, housings, power supply systems, connectors, monitors and consoles, workstations, network storage managers, video encoders, video decoders, video console displays and keyboards, all other hardware and software and documentation required to provide a completely operational and working Closed Circuit Television (CCTV) System.

B. All materials for the structured cabling system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair (25 pairs or higher)) components required for the video surveillance system shall be in compliance with specification Section 27 10 00.

C. The following parts of the system are not part of this contract:
   1. All networking equipment (switches, routers, etc) for the operation of the system
   2. All computers and software to run the security system with the exception of the items indicated in this specification.
   3. Software licenses for the video surveillance system beyond the 12 months included in this contract.

1.2 RELATED DOCUMENTS

A. General Terms and Conditions of the Contract Documents
   1. Division 26 – Electrical

B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
   1. 27 00 10 Technology General Provisions
   2. 27 05 28 Raceways for Technology
   3. 27 10 00 Structured Cabling System
   4. 27 05 26 Ground and Bonding for Communications Systems
   5. 28 10 00 Electronic Security System

1.3 CCTV INSTALLER QUALIFICATIONS

A. The Video Surveillance or CCTV installer (CI) selected for this project must be a direct representative of the products they intent to provide. All technicians assigned to install and configure this system shall be factory trained. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years under the current company

name. This company shall have a fully staffed office of sales and technical support representatives within 100 miles of this project.

B. Other required CI qualifications are:
   1. The CI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The CI shall be able to perform any and all repairs to the system within 24 hours.
   2. The CI, as a minimum, must carry a current state issued limited energy license.
   3. The CI shall have staff trained in programming the CCTV system as described in this specification. The CI shall submit as part of the qualifications required, the resume of the programmers for the CCTV system as well as the training certificates for this staff from the manufacturer of the system.

1.4 MATERIALS ALTERNATES AND SUBSTITUTION

A. General: See details for alternates and substitution in specification section 270010

B. Due to compatibility issues with other buildings under the control of the owner, the only approved Digital Video Management System (DVMS) to be provided in this project is Genetec. No substitutions are accepted for this type of equipment.

C. Cameras can be substituted as long as they have the same performance specification as the cameras used as basis of design and as long as they are supported by the DVMS. It is the responsibility of the CI to verify and assure the cameras proposed as substitution are supported by the DVMS. Any cost associated with certifying a proposed camera to the DVMS to be used in this project shall be covered by the CI.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. The CI shall follow all requirements for shop drawings indicated in specification section 27 00 10.

B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 60 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the Architect and Engineer (A&E) of the project for review, as part of the product/installer approval process.
   1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
   2. Product numbers, specifications, and data sheets for all equipment.
   3. Data sheets and samples of all labeling materials and equipment to be used in the project.
   4. A compete explanation of the identification method to be used for all equipment and cabling part of the CCTV system.
   5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
   6. Detailed drawings of all custom products to be used in the project.

7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.

C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
   1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. All cameras shall indicate the camera number in the system and the type of camera and mounting.
   2. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination. These diagrams shall be submitted for each camera type.
   3. Storage calculation. The CI shall provide a spreadsheet with all the cameras in the project and the proposed recording frame rates, resolutions, activity percentages and times of recording with the total number of storage bytes per camera and a total for the system. The total storage capacity shall be indicated in Terabytes.
   4. Bandwidth calculation. If the CI is not responsible for the networking equipment, the CI shall provide a bandwidth calculation. This calculation shall be presented in the form of a spreadsheet using MBPS as the units listing all cameras in the project. The spreadsheet shall have subtotals per network region associated with a storage area.
   5. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
   6. Video recording server assignment. A list of all the video servers to be provided in the project with a list of all cameras assigned to each server. Each server shall have a total bit rate estimated for all the cameras recorded showing that the capacity requirements of the server comply with the requirements in this specification.
   7. Panel schedules in a table format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all camera power supply, multiport encoder/decoders, computer monitor outputs, fiber optics distribution frames, Ethernet switches, patch panels, termination blocks, etc.
   8. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
   9. A field of view study. This field of view is a collection of still pictures with the precise field of view for each camera to be installed in the project. The field of view shall be the same coverage as the camera specified and will be used to verify installation of the cameras and during acceptance test.
   10. Outline of the testing process.

1.6 ABBREVIATIONS

A. The following abbreviations are used in this document:

1. API - Application Programming Interface
2. ASCII - American Standard Code for Information Interchange
3. BPS - Bits Per Second
4. CIF - Common Intermediate Format (352 X 240)
5. 2CIF - Common Intermediate Format (704 X 240)
6. 4CIF - Common Intermediate Format (704 X 480)
7. DVI - Digital Visual Interface
8. FCC - Federal Communications Commission
9. GUI - Graphical User Interface
10. HDMI - High Definition Multimedia Interface
11. ID - Identification
12. I/O - Input /Output
13. IPS - Images Per Second
14. MBPS - Mega Bits per Second
15. NTP - Network Time Protocol
16. NTSC - National Television Standard Committee
17. ODBC - Open Database Connectivity
18. ONVIF - Open Network Video Interface Forum
19. O&M - Operations and Maintenance
20. PAL - Phase Alternating Line
21. PIN - Personal Identification Number
22. PTZ - Pan/Tilt/Zoom
23. RAID - Redundant Array of Independent Disks
24. RoHS - Restriction of Hazardous Substances Directive
25. SDRAM - Synchronized Dynamic Random Access Memory
26. STP - Shielded Twisted Pair
27. TCP/IP - Transmission Control Protocol/Internet Protocol
28. UL - Underwriters Laboratories, Inc.
29. UPS - Uninterrupted Power Supply
30. USB - Universal Serial Bus
31. UTP - Unshielded Twisted Pair
32. VOC - Volatile Organic Compounds

1.7 SYSTEM DESCRIPTION

A. The CCTV system shall be a TCP/IP network-based, fully distributed digital video system. The CCTV system will utilize local area networks (LAN) as a transmission medium for video, configuration, as well as storage of all data. The CCTV system shall provide full video control at the management point indicated in the design drawings, with additional full selection capability at any point within the network from a workstation or a video console display. The CCTV system shall provide unlimited expansion capability for the addition or modification of any video device or computer workstation.

B. The CCTV system shall permit normal and event monitoring of all secured areas on digital monitors as required or shown in the specifications and drawings. In all cases, the equipment shall be state of the art, standardized commercial off-the-shelf, and modular. In all cases, the method of communication from remote locations within the network to the central components shall be transparent to the user. Equipment shall be

selected and installed so repairs may be accomplished on site by module replacement, utilizing spare components whenever possible.

C. The intent of this specification is to provide the owner with a distributed networked digital security system. Supplied by the CI, the CCTV system shall be complete and operational per the performance requirements and objectives of these specifications. The CI shall be responsible for the coordination of related work with other trades affecting his/her work or the work of others.

D. The CCTV System shall be fully integrated with other security components such as access control, alarm monitoring and intercom communications. The system shall be fully integrated with the access control application to allow events to be directly linked to the CCTV surveillance recording system. See specification section 281000 for details of the integration scope of work and the performance required.

E. All cameras shall be connected and controlled through a CCTV workstation utilizing a standard mouse and keyboard.

PART 2 - PRODUCTS

2.1 DIGITAL VIDEO MANAGEMENT SYSTEM

A. The digital video management system shall be composed of off the shelf management servers, storage system, and the DVMS Software. The recording system shall be based on a Storage Array Network (SAN) configuration. The storage system shall be composed of DVMS management server, DVMS recording servers, storage arrays, and storage expansion units.

B. The DVMS recording servers shall process all video streams for recording, live viewing, and playback for the cameras assigned to that recorder. Servers shall be provided in quantities as to not have any single server being used at more than 75% of the maximum bit rate capacity of the server. The CI shall provide calculations to the A&E of the final quantity of servers to be provided.

C. The SAN storage arrays and storage expansion shall provide a network attached storage medium for the video servers.

D. All cameras recorded at max resolution, and with frame rates as indicated in paragraph 3.4, C for a total of 90 days. It shall be the responsibility of the CI to provide the correct amount of storage based on the camera resolutions indicated on the drawings recording at the parameters provide.

2.2 DIGITAL VIDEO MANAGEMENT SYSTEM SOFTWARE

A. The CI shall provide all software required for the complete operation of the video surveillance system.

B. The approved products for this system are:
   1. Genetec – Omnicast

C. At a minimum the video surveillance system software shall provide the following key features:
   1. Ability to see live video and recorded video in the same application software.
   2. Ability to export video to an open standard file like AVI files
   3. Ability to integrate with other system with features as indicated in this specification.
   4. Support browser based clients and standard client workstation.
   5. Have video analytics incorporated into the DVMS.

2.3 DVMS STORAGE ARRAY

A. The DVMS storage array shall store all recorded video for the required amount of time. The storage array shall also provide the interface with up to three storage expansion units connected via JBOD cable.

B. Total capacity of the storage array shall be determined by the CI calculations using SATA-II hot swap disk drives in a RAID 5 configuration.

C. Each storage array shall have two 1GbE iSCSI ports for connection to the iSCSI network switch.

D. Recording software installed shall be compatible and approved for use with the Genetec Omnicast DVMS software and the manufacturer of the computer storage hardware.

E. The DVMS storage array shall match existing system being used by owner at other facilities.

2.4 DVMS STORAGE EXPANSION

A. The DMVS storage expansion shall allow an additional 24 TB of storage capacity. Each expansion unit shall connect to the DVMS storage array through a JBOD cable.

B. Total capacity of the storage expansion shall be 24 TB using 2TB SATA-II hot swap disk drives in a RAID 5 configuration.

C. The DVMS storage array shall match existing system being used by owner at other facilities.

2.5 KVM SLIDE TRAY

A. Rack mount pull out monitor, keyboard, mouse, KVM switch shall allow all equipment requiring a computer type man machine interface to utilize a single point for control and

viewing. All equipment shall connect to the KVM for control. Match specifications indicated in paragraph 2.2J on specification section 281000.

2.6 180 DEGREE MULTI-SENSOR IP CAMERA

A. The IP camera system shall include a built-in 10Base-T/100Base-TX PoE network interface for live streaming to a standard Web browser.

B. Cameras installed in outdoor locations shall be rated for the environment being installed. At a minimum the camera housings shall be IP66 and NEMA-4X rated.

C. The IP dome camera shall be provided with the appropriate accessories for mounting on wall, corner, pendant, pole, or parapet locations as indicated on the drawings.

D. The camera system for the Multi-sensor IP camera dome system shall meet or exceed the following design and performance specifications:
   1. Image Sensor: 4 x 1/2.5” CMOS sensor
   2. Effective Pixels: 4 x 8192 x 1728
   3. Lens: f1.88, fixed, automatic day/night, 5.9 mm

E. Design selection: Axis Q3819-PVE.

2.7 EXTERIOR / INTERIOR FIXED IP CAMERA (5 MP)

A. The fixed IP camera for this project can be a discrete camera with a lens mounted in a camera housing (dome or high-security enclosure) or it can be an integrated camera and dome enclosure (only when high-security enclosures not requested).

B. The fixed IP camera shall include a built-in 10Base-T/100Base-TX Poe network interface for live streaming to a standard Web browser.

C. The fixed IP camera shall operate in an IP video system environment specified for this project and shall be controllable form that platform, as well as open architecture connectivity for third-party software recording solutions.

D. The fixed IP camera shall meet or exceed the following design and performance specifications:
   1. Imaging Device: 1/1.8” CMOS
   2. Maximum resolution: 3072 X 1728
   3. Scanning System: Progressive scan
   4. Lens Type: Megapixel Varifocal with P-iris
   5. Focal Length: 4.3 mm ~ 8.6 mm
   6. Warranty: 1 year, parts and labor.

E. Design selection: Axis Q3517-LVE (Exterior) Q3517-LV (Interior)

2.8 CAMERA MOUNTS AND DOME MOUNTS

A. Camera, enclosures and dome mounts shall be provided as shown in the design drawings. The SSI shall choose the mounts based on the equipment being supported. All mounts shall be made by the same manufacturer of the cameras. Custom made mount are not acceptable, unless approved by the A&E.

B. All camera mounts and dome mounts shall be made of steel, aluminum, or stainless steel. Plastic mounts are not acceptable. Outdoor rated mounts shall be used for outdoor cameras, and indoor rated mounts shall be used for indoor cameras.

2.9 RACK MOUNTABLE CCTV CAMERA POWER SUPPLY

A. All cameras having exterior housings or connected through fiber optic cables in close proximity to the building shall be powered from a rack mountable CCTV camera power supply located in the nearest telecommunication room.

B. The rack mountable CCTV power supplies shall be UL listed, 115 VAC 50/60, 24 VAC output through 16 individually PTC protected outputs at 25amp supply current with surge protection. Total output current rating shall be equally divided among the protected outputs to support the CCTV system. The power supply shall be housed in a modular 2RU 19-inch EIA standard rack mount enclosure. The enclosure shall include a sliding rear section for easy access and a removable faceplate. Each rack mount power supply shall include spare fuses, an AC power LED indicator, internal On/Off switch, and the appropriate rack mounting hardware. All CCTV low voltage power supplies for this project shall be Altronix R2416600ULCB.

2.10 SURGE PROTECTION

A. All CCTV components mounted outside the building shall be provided with surge and lightning protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equal. For coax connections provide CX-06-BNCY line protectors manufactured by EDCO or an approved equal.

B. For exposed Ethernet connections with PoE, use EDCO CAT6-E PoE or approved equal.

2.11 WIRE & CABLE

A. Cables for analog video transmission (less than 750 ft.) shall have the following specification:
   1. Minimum cable gauge: AWG 20.
   2. Number of conductors: 1 solid coaxial cable
   3. Conductor type: Bare copper

4. Cable insulation: Foam polyolefin
5. Nominal Impedance: 75 Ohms, RG-59
6. Cable shield: 95% bare copper braid.

B. Cables for analog video transmission (less than 10 ft.) shall have the following specification:
1. Minimum cable gauge: AWG 25.
2. Number of conductors: 1 solid coaxial cable
3. Conductor type: Bare copper
4. Cable insulation: Foam polyolefin
5. Nominal Impedance: 75 Ohms, mini-RG-59
6. Cable shield: 95% bare copper braid.

C. Cables for PTZ control, RS-422 or RS-485 control lines shall have the following specifications:
1. Minimum cable gauge: AWG 24
2. Number of conductors: 2-paired, stranded conductors
3. Conductor type: Tinned copper
4. Cable insulation: Polyethylene
5. Conductor insulation colors: White-blue, blue-white white-orange and orange-white
6. Voltage rating: 300V
7. Cable shield: Aluminum/polyester foil (overall), a tinned copper braid (90% coverage) and a AWG 24 tinned copper drain wire
8. Nominal characteristic impedance: 120 Ohms
9. Nominal capacitance: 12.8 pF/ft.
10. Nominal delay: 1.6 ns/ft.
11. Nominal attenuation: 0.6 dB/100 ft @ 1 MHz.

D. Cables for camera power supply shall have the following specifications:
1. Minimum cable gauge: AWG 18
2. Number of conductors: 2, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: PVC
5. Conductor insulation colors: Black and red.
6. Voltage rating: 300V
7. Cable shield: No cable shields

E. HDMI or DVI cables shall be factory made and tested cables. For all DVI connections use an HDMI cable with HDMI to DVI adapters. All HDMI cables shall be capable of passing a signal at 340 MHz,

F. All UTP Category horizontal cables and fiber optic cables for the CCTV system shall be in compliance of all requirements in specification section 271000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 271000. Color jacket for wiring for the CCTV system shall be green.

G. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The Installer shall always estimate proper values.

H. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits.

I. Cable jackets for this project: Except when cables are run continuously in conduit all cable or patch cord cables; jackets for CCTV cables shall be plenum rated.

J. All cables shall be RoHS compliant and free of VOC. The SSI shall provide proof of compliance for all cables during the submittal process.

K. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.12 IDENTIFICATION AND LABELING TAGS

A. The CI shall follow labeling materials indicated in specification section 27 00 10.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

A. General: The CI shall follow all installation practices indicated in specification section 27 00 10

B. For all building exterior applications, CCTV imagers shall be day/night type of cameras.

C. All camera power supplies need to be installed next to the access control equipment in the same room.

D. All coaxial cable for local monitors shall be termination in a faceplate in the wall to provide means of disconnect from permanent cables. All faceplates shall be a single gang plate with BNC connectors as required for the amount of monitor cables being run for local monitoring.

E. All camera video output controls shall be adjusted to provide 1-volt peak-to-peak composite video output.

3.2 WIRING METHODS

A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers and shall comply with all state and local codes.

B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.

C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.

D. All penetrations through fire rated barriers shall be provided, by the CI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.

E. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.

F. All cameras shall have a camera interface box with disconnect means to horizontal cabling for testing purposes and service. Camera interface boxes shall be located in accessible ceiling spaces as close as possible to the camera. Disconnect means shall be provided for UTP cables in the form of an 8-pin modular plug and receptacle. Disconnect means shall be provide for low voltage camera power cables in the form of insulated spade connectors (female connectors in load side, male connectors in camera side).

G. All video cable connectors and terminations shall be 3-way crimp-on type and shall including connector cables for 24 VAC input and video/data coax output. Twist on style connectors will not be acceptable for any terminations on this project.

H. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY Raps" (Thomas & Betts or equal). Lacing of cables shall not be permitted.

I. All cable runs as part of the CCTV system in areas where ceiling is not accessible, or in building exterior, shall be in conduit at all times.

J. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.

K. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.

L. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.

3.3 IDENTIFICATION AND TAGGING

A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by pre-printed labels or tags. The permanent markings shall clearly indicate the

function, source, and destination of all cabling, wire, and terminals. All cables shall be labeled at both ends of the cable with the same and unique identifier label.

B. Cable and equipment identifiers shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the CI shall be submitted for approval to the A&E.

C. All camera power supplies, patch panels shall include a work sheet attached to the interior of the equipment cabinet in plastic envelops. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

3.4 CCTV SYSTEM PROGRAMMING

A. The CI shall program the CCTV system and the integration to the Security System as indicated in specification section 28 10 00.

B. IP Video Management System (IPVMS) programming: The CI is responsible for all programming and installation labor associated with the IPVMS and the CCTV workstations, as well as all components to make the system operational. The CI shall program the IPVMS system as to create the minimum amount of traffic in the network, and still comply with all resolutions and frame rates as indicated in this specification.

C. IP video frame rate setting: The CI shall program all settings for the IPVMS following these criteria:
   1. The system shall be programmed for 2 different modes of operation: high activity mode and low activity mode. The CI Installer shall work with the owner to establish in a regular week for each area of the building what hours in each day are considered high activity and what hours of each day are considered low activity.
   2. All cameras in low traffic interior non-public hallways or rooms shall be recorded normally at 2fps @ highest resolution during high activity mode. During high activity mode frame rate shall be increased to 15 fps upon motion detection or alarm from access control system in the field of view for at least 5 minutes after motion ceased or alarm cleared. During low activity mode these cameras shall be recorded at 1 fps @ 4CIF. Upon motion detection in the field of view of those cameras, the frame rate shall be increased to 15 fps @ highest resolution for at least 5 minutes after motion ceased.
   3. All cameras in public areas inside the building shall be recorded at least at 15 fps @ highest resolution during high activity mode. During low activity mode cameras in these areas shall be recorded at 4 fps @ 4CIF. Upon motion detection in the field of view of those cameras, the frame rate shall be increased to 15 fps @ highest resolution for at least 5 minutes after the motion ceased.
   4. All site and exterior cameras shall be recorded at 15 fps @ highest resolution at all times.

3.5 ADDITIONAL INSTALLER RESPONSIBILITIES

A. Upon project commencement, the CI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.

B. During the installation process the CI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
   1. Quantity and location of all equipment installed.
   2. Cable and wire runs along with the designations tags assigned to each.
   3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.

C. The CI Project Manager shall maintain continuous coordination with the consulting engineers. The engineers shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction, the CI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

3.6 REQUEST OF IP ADRESSES

A. The CI shall comply with all requirements indicated in specification section 27 00 10 for requesting IP address for the security system.

3.7 SYSTEM WARRANTY AND SERVICE

A. General: The CI shall follow all warranty and service requirements indicated in specification section 27 00 10.

3.8 ENGINEER'S FINAL ACCEPTANCE TEST

A. General: The SSI shall follow all test requirements indicated in specification section 27 00 10.

B. Additional requirements for the system acceptance test:
   1. The day of the final acceptance test the CI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
   2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, SSI,

General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.

3. During the final acceptance test every single camera will be tested in the system. When possible, CCTV equipment will be tested for operation during main power failure. All features requested in this specification will be tested

C. Testing of all structured cabling system part of the Video Surveillance system shall be done in accordance of specification section 27 10 00.

3.9 TRAINING AND INSTRUCTION

A. General: The CI shall follow all training requirements indicated in specification section 27 00 10.

B. The CI shall provide two (2) levels of training for this project as explained in this section.

C. OPERATOR/ADMINISTRATION TRAINING.

1. Operator/Administration training shall be provided for security and IT personnel interacting with the CCTV system in all security monitoring rooms. The purpose of this training is to explain clearly how the complete system operates and what the different status indicators mean.
2. This training shall cover at least the following topics:
   a. Operation of the CCTV system software (all aspects).
   b. Operation of all devices inside the security monitoring room.
   c. Alarm response and alarm reset in the security monitoring room
   d. Data backup/restore and achieving.
   e. File import/export.
   f. Creating reports and print outs.
   g. Basic system troubleshooting.
   h. Creating users and password reset.
3. This training shall be provided by personnel working directly for the CI or a direct employee of the manufacturer of the system.
4. One session of this type of training shall be provided and video-taped. This session shall last no less than 24 hours, broken down into day sessions no longer than 6 hours each.
5. Each session could have up to 20 trainees.
6. The approved O&M manuals shall be available at the time of the training.

D. MAINTENANCE TRAINING.

1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
2. This training shall cover at least the following topics:
   a. Trouble shooting and replacement of all field devices.
   b. Installation of all cameras and their settings (jumpers, dip switches, etc).
   c. Wire labeling system.
   d. Software system installation and recover from system crashes.

e. Detail explanation on all physical keys used in CCTV devices.
f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
g. Detail explanation of source code programming for all devices that have software code specifically compiled for this project (i.e. the control system for the video wall).

3. This training shall be provided by personnel working directly for the CI or a direct employee of the manufacturer of the system.
4. One session of this type of training shall be provided and video-taped. This session shall last no less than 18 hours, broken down into day sessions no longer than 6 hours each.
5. Each session could have up to 5 trainees.
6. The approved O&M manuals shall be available at the time of the training.

3.10 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION

A. General: The CI shall follow all as built and close out information requirements indicated in specification section 27 00 10.

B. Additional requirements for as-built documentation shall include:
1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.

C. Close out information shall also include:
1. Two (2) digital backups of all configuration files and databases part of the CCTV system not earlier than the day after the final acceptance test is approved. These backups shall include a list of all the file names used and a complete description of the system that each file name belong to. The media for these backups shall be a compatible media that can be read by the computer system running the specific software program.
2. Testing reports for structured cabling system used for the CCTV system.

END OF SECTION 28 20 00

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SECTION 28 31 00 - FIRE ALARM

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 fire alarm systems.

B. Related Sections include the following:

1. Division 8 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.3 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Addressable system; multiplexed signal transmission dedicated to fire alarm service with horn/strobes. This system shall be capable of handling the entire fire system requirements of the building including, but not limited to fire sprinkler monitoring, magnetic door hold open equipment, HVAC equipment, Elevator Recall and horn/strobes throughout the entire building.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Premises protection includes Fully Sprinkled Type Occupancy.

C. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Flame detectors.
4. Smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.
7. Fire extinguishing system operation.
8. Fire standpipe system.

D. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Unlock electric door locks in designated egress paths.
6. Release fire and smoke doors held open by magnetic door holders.
7. Activate voice/alarm communication system.
8. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
9. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
10. Record events in the system memory with ability to be printed.

E. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper.
2. Operation of any duct detectors or induct detectors.

F. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

G. System Trouble and Supervisory Signal Actions: Annunciate at the FACP and remote annunciators. Record the event on system memory with ability to be printed.

1.6 SUBMITTALS

Prior to the start of work, the contractor shall provide a complete and comprehensive submittal for review by the engineer. Once the engineer of record has reviewed and approved the submittal, the contractor shall provide a complete submittal to the Authority Having Jurisdiction for their review and approval. The contractor is responsible for obtaining and paying for the fire alarm permits that may be required. The submittals shall be prepared by a NICET III certified, factory trained personnel. This person shall provide to the engineer of record the proof of NICET certification and proof of factory training if requested. Factory training means that this person has received training at the factory. These are to describe the proposed system and its equipment. Failure to provide a complete submittal shall be grounds for summary rejection of any incomplete submittal documentation. Contractors who provide re-submittal's, due to prior rejection shall be subject to a re-review fee, should the Engineer elect to do so. The complete submittal shall include, but not be limited to, all of the following material:

A. Power Calculations

B. Battery capacity calculations shall be a minimum of 125% of the calculated requirement.

1. Supervisory power requirements for all equipment.
2. Alarm power requirements for all equipment.
3. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst case condition plus 25% spare capacity.
4. Voltage-drop calculations for wiring runs demonstrating worst case condition.

C. Complete manufacturers catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

D. Complete drawings covering the following shall be submitted by the contractor for the proposed system. Floor plans in a CAD compatible format showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used. Floor plans will be prepared at 1/8" scale.

E. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels on a flash drive and in a formatted printed form, as required for offsite editing, shall be submitted for evaluation by the owner.

F. The program shall include all required interactive control functions between the local network systems and the methods for implementing these actions.

G. Provide the address, telephone number, and contact person(s) of the manufacturer's local service facility for normal and off-hour warranty issues.

H. If the fire alarm system and its equipment are supplied by a manufacturer's distributor, as part of the submittal documentation, the manufacturer shall provide, on its corporate letterhead, a "letter of support". Said "letter of support" shall state that, when in the opinion of the Engineer, the distributor's efforts require back-up and/or assistance, the manufacturer shall provide, at no cost to the Owner, all required technical support

during the installation phase and for a one (1) year guarantee period starting on the date of final acceptance by the owner and the authority having jurisdiction. If said "letter of support" is not submitted, the manufacturer's equipment will be deemed unacceptable and shall be grounds for summary rejection.

I. Provide a fire alarm system function matrix. Matrix shall illustrate alarm output events in association with initiating devices input events. Matrix shall represent a summary of the installed system alarm, supervisory and trouble functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at the time of bid. Failure to provide this requirement shall be cause for summary rejection of submittal documents where additional departures are discovered. (See NFPA-72 for minimum matrix requirements)

J. For each system control panel and/or transponder panel, provide panel ampere loading during both normal and alarm modes, with time calculations to substantiate compliance with battery back-up power requirements (battery Ampere-Hour capacity), described elsewhere in these specifications.

K. For each system control panel and/or transponder panel, provide written schedule of active and spare addresses provided on each addressable circuit to substantiate compliance with circuit usage/spare requirements, described elsewhere in these specifications.

L. For each system control panel and system transponder notification appliance circuit provide a written schedule of spare capability in amperes available for future possible use.

M. Provide manufacture’s printed product data, catalog pages and descriptions of any special installation requirements and/or procedures. Drawings depicting any special physical installation requirements shall show physical plans, elevations, all dimensions, conduit entry, minimum access clearances and any other details required.

N. Provide shop drawings as follows:

O. Drawing or catalog page showing actual dimensions of the main FCS.

1. Drawing(s) or catalog page(s) showing actual dimensions of any additional system control panels, and/or battery cabinets.
2. Drawing or catalog page showing actual dimensions of the remote annunciator(s).
3. Single line riser diagram showing, all equipment, all connections and number and size of all conductors and conduits.
4. Provide samples of various items when so requested by the architect/engineer.

P. The fire protection contractor shall provide copies of certification for service technician’s formal training by the system manufacture. As a minimum, certification documents shall indicate training dates, systems qualified, name of individual certified and current status.

Q. Product Data: For each type of product indicated within 90 days of notice to proceed.

R. Within 30 days of notice to proceed, the contractor shall submit a programming printout and digital copy of the program to the Engineer for review.

S. Qualification Data: For Installer: NICET Level III certification within 30 days of notice to proceed.

T. Field quality-control test reports: provide test reports 10 days prior to final test requirements.

U. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

V. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.

    a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.
    b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.

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

D. 30 days after award of bid, the contractor shall conduct a meeting with the owner; owners representative, the Engineer and the architect to discuss compliance of the specifications and drawings.

1.8 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. Initiating Appliances: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
2. Detector Bases: Quantity equal to 2 percent of amount of each type installed,

but not less than 1 unit of each type.

3. Keys and Tools: One extra set for access to locked and tamper proofed components.
4. Audible and Visual Notification Appliances: One of each type installed.
5. Fuses if applicable: Two of each type installed in the system.

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. FACP and Equipment:

    a. Silent Knight by Honeywell
    b. Fire-Lite Alarms by Honeywell
    c. Gamewell/FCI by Honeywell
    d. EST
    e. Notifier by Honeywell
    f. Siemens
    g. Farenhty by Honeywell
    h. Simplex

2. Wire and Cable:

    a. Comtran Corporation.
    b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
    c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
    d. West Penn Wire/CDT; a division of Cable Design Technologies.

3. Audible and Visual Signals:

    a. System Sensor
    b. Wheelock
    c. Gentex

2.2 FACP

A. General Description:

1. Modular, power-limited design with electronic modules, UL 864 listed.
2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Signaling Line Circuits: NFPA 72, Class B.

a. System Layout: Each signaling line circuit shall be loaded no more than 80% capacity.

2. Notification-Appliance Circuits: NFPA 72, Class A.
3. Retain subparagraph above or below.
4. Notification-Appliance Circuits: NFPA 72, Class B.
5. Actuation of alarm notification appliances, annunciation, smoke control, shall occur within 10 seconds after the activation of an initiating device.
6. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Sound general alarm if the alarm is verified.
4. Cancel FACP indication and system reset if the alarm is not verified.

E. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.

F. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

G. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the

FACP and remote annunciators, after initiating devices are restored to normal.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

H. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.

J. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.

1. The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory signal supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.

1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM CIRCUIT."

L. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.

1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.
2. Battery and Charger Capacity: Comply with NFPA 72.

M. Surge Protection:

1. Install surge protection on normal ac power for the FACP and its accessories.

Comply with Division 26 Section "Transient Voltage Suppression" for auxiliary panel suppressors.

2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

N. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 FIRE ALARM DOCUMENT CABINET

A. General Description:

1. Minimum 18 gauge steel construction
2. Textured, baked on red enamel finish
3. Business card holder
4. Key ring hooks
5. Legend sheet for passwords and system information
6. Cover shall have white lettering that reads “SYSTEM RECORD DOCUMENTS”

2.4 Addressable initiation MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. 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 integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Single-action mechanism requiring single actions to initiate an alarm, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP
3. Station Reset: Key- or wrench-operated switch.
4. 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.

2.5 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Retain subparagraph above or first subparagraph and associated subparagraphs

below, or both. If retaining both, indicate detector types on Drawings.

4. Multipurpose type, containing the following:

    a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
    b. Heat sensor, combination rate-of-rise and fixed temperature.

5. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
6. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
7. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
8. Where noted on drawings provide a welded wire screen protective cover.
9. Retain subparagraph and associated subparagraphs below for analog-addressable system where remotely adjustable detectors are to be used. If both standard-addressable and analog-addressable devices are required, indicate device types on Drawings.
10. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

    a. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Verify detector sensitivity below with manufacturers selected.
3. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:

    a. Sensor: LED or infrared light source with matching silicon-cell receiver.
    b. Verify detector sensitivity below with manufacturers selected. Increased and decreased sensitivities are available to meet special environmental requirements.
    c. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating status. Provide remote status and alarm indicator and test station where indicated.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. Each sensor shall have multiple levels of detection sensitivity.
9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
10. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 NOTIFICATION APPLIANCES

A. Description: 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.
2. Where called for on plans to have a wire guard, provide and install a welded wire screen guard of appropriate size. Polycarbonate or other transparent protective covers are prohibited.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn.

C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output: as indicated.
2. Strobe Leads: Factory connected to screw terminals.
3. Where called for on plans to have a wire guard, provide and install a welded wire screen guard of appropriate size. Polycarbonate or other transparent protective covers are prohibited.

2.7 SPRINKLER SYSTEM REMOTE INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-

flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
3. Rating: 24-V dc.

B. Material and Finish: Match door hardware.

2.9 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Class 1.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LED's permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall where indicated to a circuit-breaker shunt trip for power shutdown and to release doors.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled according to UL 632.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of

telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 GUARDS FOR PHYSICAL PROTECTION

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 manufacturer of the device.
2. Finish: Paint of color to match the protected device.

2.13 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Line-Voltage Circuits: No. 12 AWG, minimum.

D. All wire and cable shall be installed in conduit.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing:

1. Smooth ceiling spacing shall not exceed [30 feet (9 m)] .
2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in

NFPA 72.

3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.

D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

E. Audible Alarm-Indicating Devices: Install between 80” and 96” above finished floor, this height is to the visual lens portion of the device, or on ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

F. Visible Alarm-Indicating Devices: Install integral to each alarm horn if noted.

G. Device Location-Indicating Lights: Locate in public space near the device they monitor.

H. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

I. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

J. Fire alarm document cabinet shall be located adjacent to the fire alarm control panel or at another location that has been approved by the AHJ. If not located at the fire alarm control panel, the exact location shall be identified on the fire alarm control panel.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:

1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring

associated with the fire alarm system, may not contain any other wire or cable.

2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM CIRCUIT."

D. The location of the branch-circuit overcurrent protective devices shall be permanently identified at the fire alarm control unit.

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation,

including connections, and to assist in field testing. Report results in writing.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to witness field tests and inspections and prepare test reports. The contractor shall provide all personnel for this test. There shall be two tests, one prior to the Fire Marshall test and one with the Fire Marshall.

C. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters.
3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.

    a. Detectors that are outside their marked sensitivity range shall be replaced.

5. Test and Inspection Records: Prepare according to NFPA 72.

D. At no time shall the contractor make changes to the documents without written permission from the Engineer.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures and Demonstration and Training."

END OF SECTION 28 31 00

Idaho Falls Police Department
Idaho Falls, ID
Bid Issue

SECTION 28 32 00 – VOICE EVACUATION 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 fire alarm systems.

1.3 DEFINITIONS

A. Retain abbreviations and terms that remain after this Section has been edited.

B. FACP: Fire alarm control panel.

C. LED: Light-emitting diode.

D. NICET: National Institute for Certification in Engineering Technologies.

E. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Addressable system; multiplexed signal transmission dedicated to fire alarm service with speaker/strobes. This system shall be capable of handling the entire fire system requirements of the building including, but not limited to fire sprinkler monitoring, magnetic door hold open equipment, HVAC equipment, Elevator Recall and speaker/strobes throughout the entire building.

1.5 PERFORMANCE REQUIREMENTS

A. Add other system requirements such as Owner's insurance company standards.

B. Comply with NFPA 72.

C. Information in paragraph below is typically requested by authorities having jurisdiction, according to NFPA 72, Subsection A-1-5.5.2.1(5).

D. Premises protection includes Fully Sprinkled Type Occupancy.

E. Edit five paragraphs and associated subparagraphs below to provide a functional description to suit Project. Revise to reflect functions required by Project.

F. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Smoke detectors.
3. Heat Detectors
4. Verified automatic alarm operation of smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire extinguishing system operation.
7. Fire standpipe system.

G. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Activate voice/alarm communication system.
6. Record events in the system memory with ability to be printed.

H. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper.
2. Operation of any duct detectors or induct detectors.

I. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.
9. Fire-pump power failure, including a dead-phase or phase-reversal condition.
10. Low-air-pressure switch operation on a dry-pipe.

J. System Trouble and Supervisory Signal Actions: Annunciate at the FACP and remote annunciators. Record the event in the system memory with ability to be printed.

1.6 SUBMITTALS

Prior to the start of work, the contractor shall provide a complete and comprehensive submittal for review by the engineer. Once the engineer of record has reviewed and approved the submittal, the contractor shall provide a complete submittal to the Authority Having Jurisdiction for their review and approval. The contractor is responsible for obtaining and paying for the fire alarm permits that may be required. The submittals shall be prepared by a NICET III certified, factory trained personnel. This person shall provide to the engineer of record the proof of NICET certification and proof of factory training if requested. Factory training means that this person has received training at the factory. These are to describe the proposed system and its equipment. Failure to provide a complete submittal shall be grounds for summary rejection of any incomplete submittal documentation. Contractors who provide re-submittal's, due to prior rejection shall be subject to a re-review fee, should the Engineer elect to do so. The complete submittal shall include, but not be limited to, all of the following material:

A. Power Calculations

1. Battery capacity calculations shall be a minimum of 125% of the calculated requirement.
2. Supervisory power requirements for all equipment.
3. Alarm power requirements for all equipment.
4. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst case condition plus 25% spare capacity.
5. Voltage-drop calculations for wiring runs demonstrating worst case condition.

B. Complete manufacturers catalog data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

C. Complete drawings covering the following shall be submitted by the contractor for the proposed system. Floor plans in a CAD compatible format showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used. Floor plans will be prepared at 1/8" scale.

D. A complete proposed system database including a description of all logic strings, control by event programming and point identification labels on a flash drive and in a formatted printed form, as required for offsite editing, shall be submitted for evaluation by the owner.

1. The program shall include all required interactive control functions between the local network systems and the methods for implementing these actions.

E. Provide the address, telephone number, and contact person(s) of the manufacturer's local service facility for normal and off-hour warranty issues.

F. If the fire alarm system and its equipment are supplied by a manufacturer's distributor, as part of the submittal documentation, the manufacturer shall provide, on its corporate letterhead, a "letter of support". Said "letter of support" shall state that, when in the opinion of the Engineer, the distributor's efforts require back-up and/or assistance, the manufacturer shall provide, at no cost to the Owner, all required technical support during the installation phase and for a one (1) year guarantee period starting on the

date of final acceptance by the owner and the authority having jurisdiction. If said "letter of support" is not submitted, the manufacturer's equipment will be deemed unacceptable and shall be grounds for summary rejection.

G. Provide a fire alarm system function matrix. Matrix shall illustrate alarm output events in association with initiating devices input events. Matrix shall represent a summary of the installed system alarm, supervisory and trouble functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at the time of bid. Failure to provide this requirement shall be cause for summary rejection of submittal documents where additional departures are discovered. (See NFPA-72 for minimum matrix requirements)

H. For each system control panel and/or transponder panel, provide panel ampere loading during both normal and alarm modes, with time calculations to substantiate compliance with battery back-up power requirements (battery Ampere-Hour capacity), described elsewhere in these specifications.

I. For each system control panel and/or transponder panel, provide written schedule of active and spare addresses provided on each addressable circuit to substantiate compliance with circuit usage/spare requirements, described elsewhere in these specifications.

J. For each system control panel and system transponder notification appliance circuit provide a written schedule of spare capability in amperes available for future possible use.

K. Provide manufacture’s printed product data, catalog pages and descriptions of any special installation requirements and/or procedures. Drawings depicting any special physical installation requirements shall show physical plans, elevations, all dimensions, conduit entry, minimum access clearances and any other details required.

L. Provide shop drawings as follows:

1. Drawing or catalog page showing actual dimensions of the main FCS.
2. Drawing(s) or catalog page(s) showing actual dimensions of any additional system control panels, amplifier cabinets and/or battery cabinets.
3. Drawing or catalog page showing actual dimensions of the remote annunciator(s).
4. Single line riser diagram showing, all equipment, all connections and number and size of all conductors and conduits.
5. Provide samples of various items when so requested by the architect/engineer.

M. The fire protection contractor shall provide copies of certification for service technician’s formal training by the system manufacture. As a minimum, certification documents shall indicate training dates, systems qualified, name of individual certified and current status.

N. Product Data: For each type of product indicated within 90 days of notice to proceed.

O. Within 30 days of notice to proceed, the contractor shall submit a programming printout and digital copy of the program to the Engineer for review.

P. Retain subparagraph below for projects where routing of cable or conduit is critical and only outlet locations are shown on Drawings. Delete reference to device addresses if shown on Drawings.

Q. Coordinate paragraph below with qualification requirements in Division 1 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

R. Qualification Data: For Installer and fire alarm submittal designer: NICET Level III certification within 30 days of notice to proceed.

S. Retain first paragraph below if Contractor is responsible for field quality-control testing.

T. Field quality-control test reports: provide test reports 10 days prior to final test requirements.

U. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

V. Retain paragraph below where appropriate. See Editing Instruction No. 2 in the Evaluations.

W. See Editing Instruction No. 3 in the Evaluations for discussion of "Permanent Records."

X. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.

    a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.
    b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

A. Retain one of first three paragraphs below.

B. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

C. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.

D. 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.

E. 30 days after award of bid, the contractor shall conduct a meeting with the owner;

owner's representative, the Engineer and the architect to discuss compliance of the specifications and drawings.

1.8 EXTRA MATERIALS

A. Extra materials may not be allowed for publicly funded projects.

B. 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. Initiating Appliances: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
2. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
3. Keys and Tools: One extra set for access to locked and tamper proofed components.
4. Audible and Visual Notification Appliances: One of each type installed.
5. Fuses if applicable: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products.

B. 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:

C. Retain above for nonproprietary or below for semiproprietary specification. Refer to Division 1 Section "Product Requirements."

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

1. FACP, Amplifiers and Equipment:

a. Silent Knight by Honeywell
b. Fire-Lite Alarms by Honeywell
c. Gamewell/FCI by Honeywell
d. EST
e. Notifier by Honeywell
f. Siemens
g. Potter
h. Farenhyt by Honeywell
i. Simplex

j. Autocall

2. Wire and Cable:

a. Comtran Corporation.
b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
d. West Penn Wire/CDT; a division of Cable Design Technologies.

3. Audible and Visual Signals:

a. System Sensor
b. Wheelock
c. Gentex

2.2 FACP

A. Retain and adjust general features in first paragraph and subparagraphs below. Coordinate with implementation details and Drawings. Addressable horns are available for special-notification appliance circuits; add a subparagraph if in Project.

B. General Description:

1. Modular, power-limited design with electronic modules, UL 864 listed.
2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

D. Circuits:

1. Signaling Line Circuits: NFPA 72, Class B.

    a. System Layout: Each signaling line circuit shall be loaded no more than 80% capacity.

2. Notification-Appliance Circuits: NFPA 72, Class A.
3. Notification-Appliance Circuits: NFPA 72, Class B.

4. Actuation of alarm notification appliances, annunciation, smoke control, shall occur within 10 seconds after the activation of an initiating device.

5. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

E. Retain first paragraph and subparagraphs below for systems with smoke-alarm verification. Alarm verification is generally not recommended for duct detectors.

F. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Sound general alarm if the alarm is verified.
4. Cancel FACP indication and system reset if the alarm is not verified.

G. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.

H. Retain one of first two paragraphs below for buildings with elevators. Edit to suit interpretations of NFPA 72 and ANSI A17.1 by authorities having jurisdiction.

I. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

J. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

K. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The

FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

L. Retain first paragraph below for analog-addressable systems with analog-addressable smoke detectors. For alarm verification, confirm that the specified detector type is available with alarm verification.

M. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.

N. Service Modem: Ports shall be RS-232 for system printer and for connection to a dial-in terminal unit.

1. The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

O. Retain paragraph below if printers are part of system.

P. First paragraph below is for two-wire supply. Revise this paragraph and the "Power Supply for Supervision Equipment" Paragraph in this Article if three-wire supply or an external dc supply is provided.

Q. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory signal supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.

1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM CIRCUIT."

R. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.

1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.
2. Battery and Charger Capacity: Comply with NFPA 72.

S. Surge Protection:

1. Install surge protection on normal ac power for the FACP and its accessories. Comply with Division 26 Section "Transient Voltage Suppression" for auxiliary panel suppressors.
2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

T. Retain below to specify printed instructions for all projects in which a new FACP is provided or functions of an existing FACP are modified.

U. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 FIRE ALARM DOCUMENT CABINET

A. Retain and adjust general features in first paragraph and subparagraphs below. Coordinate with implementation details and Drawings. Addressable horns are available for special-notification appliance circuits; add a subparagraph if in Project.

B. General Description:

1. Minimum 18 gauge steel construction
2. Textured, baked on red enamel finish
3. Business card holder
4. Key ring hooks
5. Legend sheet for passwords and system information
6. Cover shall have white lettering that reads “SYSTEM RECORD DOCUMENTS”

2.4 MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. 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 integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Single-action mechanism requiring single action to initiate an alarm, pull-lever type with integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
3. Station Reset: Key- or wrench-operated switch.
4. 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.

2.5 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

3. Multipurpose type, containing the following:

   a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
   b. Heat sensor, combination rate-of-rise and fixed temperature.

4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
7. Where noted on drawings provide a welded wire screen protective cover.

8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

   a. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Verify detector sensitivity below with manufacturers selected.
3. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:

   a. Sensor: LED or infrared light source with matching silicon-cell receiver.
   a. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

2. Retain subparagraph and associated subparagraphs above for photoelectric smoke detectors or first subparagraph and associated subparagraphs below for

ionization smoke detectors. If both types are required, indicate detector types on Drawings.

3. UL 268A listed, operating at 24-V dc, nominal.
4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
5. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

    a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

6. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
7. Integral Visual-Indicating Light: LED type. Indicating status. Provide remote status and alarm indicator and test station where indicated.

8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

9. Each sensor shall have multiple levels of detection sensitivity.
10. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
11. Relay fan shutdown: Rated to interrupt fan motor-control circuit.

2.6 NOTIFICATION APPLIANCES

A. Coordinate this Article with Drawings. See Editing Instruction No. 9 in the Evaluations for discussion of ADA requirements.

B. Description: 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.

C. Revise sound-level values in first four paragraphs below to comply with local interpretations of ADA requirements. See Editing Instruction No. 10 in the Evaluations.

D. Speakers: shall be of sufficient number so that an alarm shall be clearly audible to all occupants of the building and/or fire area as required by these specifications. Mounting height shall be 96” to the centerline of the unit above the finished floor. Locations where ceilings prevent the installation at 96” centerline, the centerline of the unit shall be 6” below the ceiling.

E. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is

engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output: as indicated.
2. Strobe Leads: Factory connected to screw terminals.
3. Where called for on plans to have a wire guard, provide and install a welded wire screen guard of appropriate size. Polycarbonate or other transparent protective covers are prohibited.

2.7 SPRINKLER SYSTEM REMOTE INDICATORS

A. Retain this Article if required. Coordinate with Drawings.

B. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 MAGNETIC DOOR HOLDERS

A. Coordinate first paragraph and subparagraphs below with Drawings and with Division 8 Section "Hardware."

B. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
3. Rating: 24-V dc.

C. Material and Finish: Match door hardware.

2.9 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.

2. Mounting: Flush cabinet, NEMA 250, Class 1.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LED’s permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Retain below for elevator recall or shutdown duty.

C. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall where indicated to a circuit-breaker shunt trip for power shutdown and to release doors.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Retain this Article if Project requires telephone transmission of fire alarm, supervisory, and trouble signals to a remote alarm receiving station or other remote location. Unit specified is compatible with most central-station receiving equipment, but verify specific compatibility and acceptability of this signal transmission method for each Project.

B. Listed and labeled according to UL 632.

C. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

D. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

E. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 GUARDS FOR PHYSICAL PROTECTION

A. Retain this Article if items are installed in gymnasiums and other spaces where they will be exposed to physical damage.

B. 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 manufacturer of the device.
2. Finish: Paint of color to match the protected device.

2.13 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Adjust wire size in first paragraph below to suit Project. NFPA 70 permits wire sizes down to No. 26 AWG.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.

1. Retain subparagraph below if use of cable is an option.
2. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Adjust wire size in two subparagraphs below to suit Project. NFPA 70 permits wire sizes down to No. 18 AWG.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. All wire and cable shall be installed in conduit.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Delete paragraph and subparagraphs below if spacing is indicated on Drawings. See Editing Instruction No. 12 in the Evaluations for discussion of detector locations.

B. Smoke or Heat Detector Spacing:

1. Edit first subparagraph below to indicate how Contractor shall determine detector spacing.
2. Smooth ceiling spacing shall not exceed [30 feet (9 m)] .
3. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
4. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

C. See Editing Instruction No. 13 in the Evaluations for discussion of placement of smoke detectors with respect to HVAC air inlets and outlets.

D. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.

F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Coordinate first paragraph below with Drawings.

H. Audible Alarm-Indicating Devices: Install between 80” and 96” above finished floor, this height is to the visual lens portion of the device, or on ceiling. Install speakers on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

I. Visible Alarm-Indicating Devices: Install integral to each alarm speaker if noted.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

K. FACP: Mount as noted on drawings with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

L. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:

1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Retain paragraph and subparagraph above or first paragraph and subparagraphs below.

D. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

E. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

F. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

G. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

H. For Class A circuits, provide separate conduits or cable for outgoing and return conductors; coordinate with Drawings. Retain paragraph below if required.

I. Retain below if system is monitored by remote central station, or for remodeling and alteration projects where fire alarm system exists and new connections are made to central-station transmitter. Supervised circuits are required for alarm and supervisory functions.

J. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM CIRCUIT."

D. The location of the branch-circuit overcurrent protective device shall be permanently identified at the fire alarm control unit.

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

A. Retain paragraph below to require a factory-authorized service representative to perform, or assist Contractor with, field inspections, tests, and adjustments. Retain one of two options to suit Project; delete both to require only an inspection before field testing.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

C. Retain one of three paragraphs below.

D. Testing Agency: Owner will engage a qualified testing and inspecting agency to witness field tests and inspections and prepare test reports. The contractor shall provide all personnel for this test. There shall be two tests, one prior to the Fire Marshall test and one with the Fire Marshall.

E. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters.

3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.

    a. Detectors that are outside their marked sensitivity range shall be replaced.

5. Test and Inspection Records: Prepare according to NFPA 72.

F. D. At no time shall the contractor make changes to the documents without written permission from the Engineer.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures and Demonstration and

Training."

END OF SECTION 28 32 00

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SECTION 28 50 00 EMERGENCY RADIO COMMUNICATION ENHANCEMENT SYSTEM (BDA SYSTEM)

PART 1 - GENERAL

1.1 SUMMARY

A. General:

1. Provide an in-building radio signal amplification system to provide complete coverage in the building for the public safety agencies as required by the local AHJ (Authority Having Jurisdiction). System users shall receive and transmit radio signals from their portable radio units within the building. This shall be accomplished utilizing the following components:

    a. Bi Directional Amplifiers (Signal Boosters)
    b. Coaxial Cable
    c. Antennas
    d. Cable taps
    e. Connectors
    f. Power dividers
    g. Other components and interconnecting circuitry as required

2. The system shall comply with the requrements of UL2524 In-building 2-Way Emergency Radio Communication Enhancement Systems, NFPA 72 2013 Edition, NFPA 1221 2016 Edition and IFC 2015, as referenced.
3. The entire system shall meet the requirements of the Fire Department, the Building Department and all other agencies and authorities having jurisdiction (AHJ).
4. The work in this section shall include the responsibility for all permit requirements with the AHJ. Where filings require engineer’s signature, documents shall be submitted for his review and signature. This responsibility shall include furnishing of required quantities of floor plans, descriptive notes and/or specifications, wiring diagrams, shop drawings and amendment forms.
5. Early completion of the in-building emergency radio communication enhancement system will be required as to permit a Certificate of Occupancy to be obtained in a timely manner
6. Any permits necessary for the installation of the work shall be obtained prior to the commencement of the work. All permit costs and inspection fees shall be included
7. The in-building emergency radio communication enhancement system shall use a UL2524, NFPA 72, NFPA 1221 and IFC 2018 compliant GAMEWELL-FCI signal booster or approved equal.

1.2 DESIGN REQUIREMENTS

A. In-building emergency radio communication enhancement systems for emergency

responders are an integral component of the life safety equipment of a building or structure. The primary function is to provide reliable emergency responder communications at the required signal strength within the specified areas.

B. Critical Areas such as emergency command center, fire pump room, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations and similar critical areas shall be provided with 100% floor area radio coverage.

C. General building areas shall be provided with 95% radio coverage, or as specified by AHJ.

D. The In-building emergency radio communication enhancement systems must provide the following signal strengths:

1. Downlink - Minimum signal strength of -95 dBm throughout the coverage area.
2. Uplink - Minimum signal strength of -95 dBm received at the AHJ Radio System.
3. OR As otherwise required by the AHJ
4. The system shall be complete with all components and wiring required for compliance with all applicable codes and regulations, and for its operations described hereinafter.
5. An approved manufacturer or a qualified and approved vendor shall supply, test and determine locations of components which are required for proper operation as well as to supply, install, test and certify the performance of the complete system. Vendor qualifications must be acceptable to the AHJ.
6. Design shall include iBwave software-simulated radio propagation modeling with heat maps showing predicted signal coverage levels within the building. The iBWave design shall be done by iBWave certified personnel.
7. All tests shall be conducted, documented, and signed by a person in possession of an FCC General Radio Telephone Operators License. All testing personnel shall be certified and authorized by the signal booster manufacturer in the installation and operation of their equipment. Personnel qualifications must be acceptable to the AHJ.
8. The system design shall be based on the GAMEWELL-FCI line of Public Safety Signal Boosters UL2524, NFPA 72, NFPA 1221, IFC and FCC certified to establish standards of quality for materials and performance. The naming of a specific manufacturer or a catalog number does not waiver any requirement or performance of individual components described in the specifications.
9. Assembly and installation of all components of the Emergency Responder Radio Communication Enhancement System shall comply with all applicable sections of the National Electrical Code.
10. Survivability from attack by fire shall meet requirements of NFPA 72, NFPA 1221, IFC or as required by the local jurisdiction.
11. The system must comply with all applicable sections of the FCC rules. Signal booster shall have FCC certification prior to installation.
12. Antenna isolation shall be maintained between the donor antenna and all inside antennas (D.A.S.) to a minimum of 20dB under all operating conditions

PART 2 - PRODUCTS

2.1 TECHNICAL SPECIFICATIONS AND PERFORMANCE REQUIREMENTS

A. The system specified shall be based upon GAMEWELL-FCI line of Public Safety UL2524, NFPA72, NFPA 1221, IFC compliant signal boosters

B. The signal booster shall be a Class B Public Safety type as designated by the FCC or as required by the AHJ.

C. The secondary power supplies, battery chargers and system monitoring shall be fully compliant with NFPA 72, NFPA 1221 and IFC. The signal booster shall have both the primary and the secondary power supplies within a waterproof, type-4 approved enclosure.

D. All signal boosters and other active system components must have FCC certification prior to installation. The equipment FCC ID must be shown on the product datasheets and technical submittals. The ID must also be displayed on the product as required by the FCC.

E. The signal booster shall be pre-set by the equipment manufacturer for the frequencies specified by the AHJ. Field tuning of RF filters and duplexers is not allowed.

F. UHF and VHF signal boosters shall be band selective type with a maximum 3dB channel bandwidth of 200KHz (Fc +/- 100KHz) per band. Non-selective wide-band signal boosters shall not be accepted, unless required to cover multiple channels within the same band.

G. Signal Boosters shall have oscillation suppression circuitry to protect the public safety radio system in case of system malfunction or other causes. The oscillation suppression circuit shall not disable the system operation. Systems that automatically disable the signal booster upon oscillation detection shall not be allowed.

H. Signal Boosters shall have uplink noise suppression function to eliminate uplink noise while in standby (i.e. no radio transmission from within a building). Systems that produce any measurable level of uplink noise while in standby shall not be allowed.

I. Signal Booster gain shall be rated at minimum of 80dB and the gain shall be adjustable in a minimum of 30dB range. System gain shall be set and documented at the time of the final system test.

J. Maximum Propagation delay of the signal booster system shall be 14μs (microseconds) or as specified by AHJ.

K. The signal booster system shall include built-in automatic supervision of malfunctions of the signal booster and battery system as per NFPA 1221 NFPA 72 and IFC. Non-OEM equipment add-ons and modifications to comply with this specification shall not be allowed.

L. A dedicated supervised monitoring panel shall be provided within the emergency command center next to the fire alarm panel / annunciator or other location as designated by AHJ to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each

signal booster:

1. Normal AC power
2. Signal booster trouble
3. Antenna Failure
4. Loss of normal AC power
5. Failure of battery charger
6. Low battery capacity

M. If signal booster is supervised by a GAMEWELL-FCI fire alarm panel, the signal booster system shall include a compatible, OEM built-in GAMEWELL-FCI addressable monitoring module If signal booster is supervised by other brand FACP, the signal booster shall be Honeywell branded model with universal normally open relays for connection to external monitoring modules.

N. External filters, duplexers, power supplies or other non-OEM additions or modifications of the original equipment shall not be allowed. All duplexers shall be built-in and FCC certified with the signal booster as a complete and fully integrated FCC-certified and UL-Listed unit.

O. All signal booster components shall be contained in a type-4 approved waterproof enclosure. All enclosures shall be painted red with external labeling as required by the AHJ.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Installation of all components of the Emergency Responder Communication Enhancement System shall comply with all applicable sections of the National Electrical Code NFPA-70, NFPA-72, NFPA 1221, IFC or as required by the local AHJ.

B. At least 2 independent and reliable power supplies shall be provided as specified in NFPA 72, NFPA 1221 and IFC.

C. The primary power source shall be supplied from a dedicated twenty (20) ampere branch circuit and comply with NFPA-70 National Electrical Code, NFPA 72 and NFPA 1221 2016 edition.

1. The signal booster shall be equipped with a secondary source of power. The secondary source of power shall be a battery system with a dedicated battery charger powered by a separate, dedicated twenty (20) ampere branch circuit. The secondary power supply shall power on automatically when the primary power source is lost. The secondary source of power shall be capable of operating the emergency responder radio coverage enhancement system for a period of at least 24 hours. The battery system shall automatically charge in the presence of external power input. Battery charger and all other electronic components must be fully enclosed in a waterproof Type-4 approved enclosure. Batteries shall be enclosed in a separate, vented Type-3R approved enclosure.

External UPS (Uninterruptable Power Supplies) are not acceptable..

D. RF Coaxial Cable shall be a listed, CMP plenum. Non-plenum cable can be used when installed in a metallic raceway. The cable classification shall be clearly marked on the outer surface of the cable regular intervals.

E. Acceptance and Test Procedures

1. Acceptance testing for an in-building radio system is required upon completion of installation.
2. The coverage testing shall be done in accordance with NFPA 72, NFPA 1221, IFC and as required by the local AHJ
3. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio Operator License.
4. All test records along with system diagrams, iBWave design, equipment specifications, user manuals, RF link budget calculations, battery backup calculation and other design data shall be submitted upon completion of the project, and as required by the AHJ.

END OF SECTION 28 50 00

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SECTION 28 55 00- RF SURVEY FOR EMERGENCY RESPONDER RADIO ANTENNA

PART 1 - GENERAL

1.1 SUMMARY

A. The purpose of this specification is to establish the requirements and standards for initial survey for public safety radio signal strength per NFPA and IFC

B. Survey should be performed after the building is substantially completed, and prior to start of installation of electrical wiring.

C. Conduct a survey using a RF Spectrum Analyzer, a calibrated, system-compatible radio or another suitable instrument with traceable certificate of calibration to analyze the RF signal strength of Emergency Responder Radio Signal into the building and determine if amplification of the signal is required. Both inbound and outbound signal strength shall be determined, measured, calculated and documented as required by code.

1.2 SURVEY CRITERIA IF REQUIRED

A. The required Public Safety Radio Signal Level inside the Owner's facility must be determined per code, ordinance or AHJ

B. Survey shall be performed by an FCC licensed technician holding a current GROL license. Honeywell Fire have distributors that meet these requirements.

1.3 REGULATIONS

A. A. Codes, regulations and standards referenced in the Section are:

1. NFPA 1 – The National Fire Code (including Annex O from 2009)
2. NFPA 70 – The National Electrical Code
3. IFC 510- Emergency Responder Radio Coverage
4. NFPA 101, Life Safety Code, the Ohio Building Code, and Local Code and Building Authority requirements.
5. NFPA 72 National Fire Alarm Code
6. FCC 47 CFR Private Land Mobile Radio
7. 90.219 Services-Use of Signal Boosters
8. ICC International Fire Code, Code and Commentary
9. Local or State Promulgated Fire Code
10. ADA "Americans with Disabilities Act"
11. FCC's OET 65 Standards "Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields"
12. FCC Rules Part 22, Part 90 and Part 101
13. NFPA 1221 2016 Edition
14. International Building Code 2012 / 2015 / 2018
15. UL 2524

1.4 DEFINITIONS

A. Definitions:

1. Bi-Directional Amplifier BDA: Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station and in the downlink from the base station to subscriber devices for enhanced signals and improved coverage.
2. Emergency Responder Radio Coverage System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services, or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.
3. FCC: Federal Communications Commission
4. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
5. Public Safety/First Responder: Public Safety or First Responder agencies that are charged with the responsibility of responding to emergency situations. These include, but are not limited to law enforcement departments, fire departments, and emergency medical companies.
6. RSSI: Received signal strength indicator RSSI is a measurement of the power present in a received radio signal.
7. BER: Bit Error Rate is the number of bit errors per unit time
8. GROL- FCC General Radio Operators License
9. ERRCES- Emergency Responder Radio Coverage Enhancement System
10. DAS-Distributed Antenna System

1.5 EXECUTION

A. Testing Procedures

1. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the. -95dBm nominal signal at 100%.
2. Spectrum Analyzer or Calibrated Handheld Radio shall be used as basis for signal measurements or other method as approved by AHJ.
3. Testing should be based on a minimum of 20 grid locations per floor OR maximum of 1600 SQ ft. areas if the floor exceeds 32,000 Sq. Ft. Also, testing should include all critical areas per NFPA. See 1.02 of this specification and NFPA 72 2013 or NFPA 1221 2016. OR per any method determined by the AHJ, local code or ordinance.
4. A minimum signal strength of -95 dBm shall be provided throughout the coverage area for both uplink and downlink by the Local Fire Department.

    a. RSSI measurement only

1.6 SURVEY SUBMITTALS

A. Submit testing data for each level of the building.

1. 1. An RF measurement drawing of each floor of the building which indicates relative RF field strength for each frequency band of interest must be submitted to the AHJ.
2. 2. The drawing should indicate clearly the areas that have passed or failed based on the above parameters.

END OF SECTION 28 55 00

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SECTION 31 31 16 - TERMITE CONTROL

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 pre-construction soil treatment for underslab and foundation wall perimeters.

1.3 SUBMITTALS

A. Submit the following according to Division 01 requirements.

B. Product Data:

1. Chemicals and products used
2. Application instructions
3. Certification that products used comply with U.S. Environmental Protection Agency (EPA) regulations for termiticides.
4. Information that soil treatment conforms to specified requirements

C. Provide information regarding the type of equipment to be used to apply the soil treatment, size of volume mixing tank, the pump capacity in gallons per minute, and the application tools with in-line flow meter devices attached.

D. Certificate of Compliance: Submit as part of the Close Out Documents the following statement from the pest control company: “The building has received a complete treatment for the prevention of subterranean termites. Treatment is in accordance with rules and laws established by the Department of Agriculture and Consumer Services.”

E. Submit job site log book.

F. Submit warranty.

1.4 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for preparing substrate and application.

B. Engage a professional pest control operator who is licensed according to regulations of the State of the project.

C. Use only termiticides that bear a federal registration number of the EPA and are approved by local authorities having jurisdiction.

1.5 FIELD CONDITIONS

A. Soil Treatment:

1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.6 REGULATORY REQUIREMENTS

A. Minimum requirements for application as authorized by the State of the project to fulfill the work according to manufacturer's specifications.

1.7 PROJECT RECORD DOCUMENTATION

A. Log Book to be kept at job site ad to include:

1. Project name
2. Company providing treatment
3. Applicator's name
4. Time of arrival and departure
5. Product name
6. Record date of all applications
7. Rate of application to all required areas of the designated site
8. All areas to be treated
9. The soil treatment trade name
10. Quantity of concentrate delivered to the site
11. Quantity used for the designated treated areas
12. The percentage of active ingredient in diluted form
13. Finished gallons of soil treatment for each application
14. Linear and square footage amount to determine total finished soil treatment used

B. Architect will observe both the amount of concentrate delivered to the site and the empty units that total the amount used to the treated areas. The Owner's representative shall sign the logbook as noted.

1.8 DELIVERY

A. The State Registered products must be delivered to the jobsite in the original sealed and labeled containers of the manufacturer. Use a synthetic dye for proper identification on the surface areas treated.

1.9 WARRANTY

A. Warranty: Furnish written warranty, executed by Applicator and Contractor, certifying that applied soil termiticide treatment will prevent infestation of subterranean termites. If subterranean termite activity is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

B. Warranty Period: 5 years from Date of Substantial Completion, or the minimum more than 5 years if prevailing local laws require.

C. The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1.10 PROJECT CONDITIONS

A. Restrictions: Do not apply soil treatment solution until excavating, filling, and grading operations are completed, except as otherwise required in construction operations.

B. To ensure penetration, do not apply soil treatment to excessively wet soils or during inclement weather. Comply with handling and application instructions of the soil toxicant manufacturer.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

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. BASF Corporation, Agricultural Products; Termidor SC
b. Bayer Environmental Science; Premise 75 WP.
c. FMC Corporation, Agricultural Products Group; Dragnet FT.

d. Syngenta; Demon Max.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.

2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and along the entire outside perimeter, from grade to bottom of footing.
3. Masonry: Treat voids.
4. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

B. Post warning signs in areas of application.

C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

END OF SECTION 31 31 16

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SECTION 32 31 00 - HEAVY DUTY GATES

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. Heavy Duty, manually operated, cantilevered slide and swing gates.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review sequence of operation for each type of gate operator.
3. Review coordination of interlocked equipment specified in this Section and elsewhere.
4. Review required testing, inspecting, and certifying procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Gate fabric, reinforcements, and attachments.
b. Gates and hardware.
c. Gate operators, including operating instructions and motor characteristics.

B. Shop Drawings: For each type of gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.
3. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.

4. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For each type of factory-applied finish.

D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

E. Delegated-Design Submittal: For structural performance of posts, framing and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of chain-link and gate.

B. Product Certificates: For each type of chain-link, operator, and gate.

C. Product Test Reports: For framework strength according to ASTM F1043, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

D. Welding certificates.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

C. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify layout information gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
c. Faulty operation of gate operators and controls.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, to design gate frameworks.

B. Structural Performance: Gate and frameworks shall withstand the design wind loads and stresses for gate height(s) and under exposure conditions indicated according to ASCE/SEI 7.

1. Design Wind Load: As indicated on Drawings.

C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along gate under normal dry conditions.

2.2 SWING GATES

A. Basis of Design product and Manufacturer; Tymetal a Fort Miller Group Company, Model, Fortress Heavy Duty aluminum swing gate.

B. Gate Frame:

1. The gate frame shall be fabricated from 6063-T6 aluminum alloy extrusions. The top member shall be a 3" x 5" aluminum structural channel/tube extrusion weighing not less than 3.0 lb/lf. The bottom member shall be a 2” x 5" aluminum structural tube weighing not less than 2.0 lb/lf.
2. Vertical Members:

a. Chain Link: The vertical members at the ends of the opening portion of the frame shall be "P" shaped in cross section with a nominal base dimension of no less than 2” x 2” and weighing not less than 1.6 lb/lf. The intermediate vertical members shall alternate between 2” x 2” and 1” x 2” in cross section weighing not less than 1.1 lb/lf and 0.82 lb/lf respectively. The spacing for the vertical intermediates shall be less than 50% of the gate frame height.

3. All welds on the gate frame shall conform to Welding Procedure Specification and Procedure Qualification Record to insure conformance to the AWS D1.2 Structural Welding Code. All individual welders shall be certified to AWS D1.2 welding code.
4. Each gate leaf shall be provided with a minimum of two pivoting hinges to allow proper operation, and shall be connected to the gate side of the hinge by means of two through-bolts.

C. Diagonal Bracing:

1. Diagonal "X" bracing of 3/16" or 1/4” diameter stainless or galvanized steel cable shall be installed throughout the gate to provide additional vertical adjustment.

D. Posts:

1. Gate hanger posts shall be sized in accordance with gate dimensions as specified by the manufacturer. Height of the post and depth of footing shall be as specified by the engineer.

E. Lock:

1. Single gates shall have a latch assembly to provide a means for locking with a padlock.
2. Double gates shall have a drop-bar mechanism extending into the ground, and a center locking kit to provide a means for locking with a padlock.

F. The gate shall be completed by installation of approved filler as specified.

1. Chain Link: 2” x 2” x 9 gauge aluminized steel chain link fabric shall extend the entire length of the gate panel. Fabric shall be attached at each end of the gate frame by standard fence industry tension bars and tied at each 2” x 2” (51mm x 51mm) vertical member with standard fence industry ties. ASTM F 2200 requires attachment method that leaves no leading or bottom edge protrusions (cannot exceed 0.5 inch).

G. Finish:

1. Gate to be color coated with polyester powder as specified. If powder coated, the gate (including track member) and all accessories shall be pretreated chemically by sand blasting or other acceptable method to ensure proper coating adherence.

2.3 GATE OPERATOR DETAILS

A. Model TYM-200-SW swing gate operator shall open and close swing gates, providing convenience and security. This model is adapted to function with most accessories including: radio controls, single and three button control stations, digital keypads, sensing loops. The TYM-200-SW is available in 115/208/230 Volt AC single phase or 208/230/460 Volt AC three phase power. Control voltage in each case is 24 Volt DC.

2.4 CONTROLLER

A. Features include and integral APeX Controller. Operation shall be by means of 1 horsepower single or three phase C-faced instant reversing motor, transferring power to a heavy-duty right-angle oil bath gear reducer. Power is transferred from the gear reducer to a heavy duty 3 inch diameter torque limiter and #40 plate sprocket. From the torque limiter, power transfers to the 1-1/8 inch output drive shaft with solid cast aluminum arm crank and harmonic action articulating swing gate arm attached to the gate.

2.5 ARTICULATING ARM

A. The Articulating arm shall cycle the gate through to a 90-degree opening in approximately 13-15 seconds using manufacturer recommended installation. By use of an articulating arm design, the gate will start moving slowly, gradually increase in speed, the slow down again as it approaches full open.

2.6 COMPONENTS

A. Standard mechanical components shall include as a minimum:

1. 14 Gauge weather-resistant galvannealed steel cabinet.
2. Gasketed cabinet door which is removable and lockable.
3. 1 – inch solid steel output drive shaft.
4. Heavy-duty right angle oil bath C-face gear reducer.
5. Heavy-duty pillow block bearings with grease fittings for easy maintenance.
6. Heavy-duty 3 inch diameter torque limiter.
7. Dual C-face 6 foot pound brake.
8. All welded interior steel framework.
9. Steel articulating style gate arm with manual disconnect pin, which is lockable.
10. Powder coat finish.

B. Standard electrical components shall include as a minimum:

1. 1 HP motor with thermal overload protection in 115 and 230 VAC single phase or 230 or 460 VAC three phase.
2. APeX Solid state logic controller featuring 15 diagnostic L.E.D. indicators and auto-close timer (1 second to 9 minutes)

3. Inherent, adjustable motor over-current sensing to detect obstructions, with separate adjustments for opening and closing directions.
4. Controller housed in zinc plated control box.
5. Power On/Off switch. In 115 VAC units, 115 VAC duplex outlets included.
6. Contacts for opening, closing and reversing accessories, as well as contact and non-contact obstruction sensing devices. 24 VDC available on terminal strip to power accessory devices.
7. Adjustable limits with precision snap-action type limit switches to control gate position.
8. Paired operation / master slave or stand alone capable with dip switch selection. Three wire twisted pair shielded cable required for paired operation.

C. Accessories, contact, non-contact, and control devices.

1. Control devices include pushbuttons, radio controls, keypad, card readers, key switches.
2. Contact and non-contact devices include photoelectric sensors, vehicle detectors, proximity sensors, and contact devices.
3. UL325 requires that should there be a space greater than 4” between the lowest point of grade and the bottom of the gate frame, Safety Edges are required on both sides of the gate frame on the leading edge of the gate panel. (See 3.01 B).
4. Accessories include flashing strobe lights, cycle counters, and intercom systems.

2.7 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.8 GROUNDING MATERIALS

A. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

3.2 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.3 GATE-OPERATOR INSTALLATION

A. Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Vehicle Loop Detector System: Bury wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.

C. Ground electric-powered motors, controls, and other devices according to NFPA 70 and manufacturer's written instructions.

3.4 GROUNDING AND BONDING

A. Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
3. Ground fence on each side of gates and other fence openings.

a. Bond metal gates to gate posts.
b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

C. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
3. Make above-grade ground connections with mechanical fasteners.
4. Make below-grade ground connections with exothermic welds.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

D. Bonding to Lightning Protection System: Ground and bond grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

3.5 SYSTEM VALIDATION

A. The complete system shall be adjusted to assure it is performing properly.

B. The system shall be operated for a sufficient period of time to determine that the system is in proper working order.

C. For operated gate systems - test and explain safety features:

1. Each system feature and device is a separate component of the gate system.
2. Read and follow all instructions for each component.
3. Ensure that all instructions for mechanical components, safety devices and the gate operator are available for everyone who will be using the gate system.
4. The warning signs shipped with the gate operator must be installed in prominent position on both sides of the gate.
5. Ensure the owner is clear with regard to the safety points concerning the basic operational guidelines of the safety features of the gate operator system. These safety points are listed in the gate operator manual and must be read prior to system use.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests.

B. Prepare test reports.

3.7 FACTORY INSPECTION AND TESTING

A. Manufacturer shall test each operator at factory to assure smooth operation.

B. Manufacturer shall test all control inputs to ensure proper function.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices, start units, and verify proper motor rotation and unit operation.

1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Test and adjust operators, controls, alarms, and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Lubricate operator and related components.

C. Lubricate hardware and other moving parts.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gates.

END OF SECTION 32 31 00

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SECTION 32 31 05 – VERTICAL PIVOTING GATES

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. Vertical pivot gate system including gates and Tilt-A-Way hydraulic operator, with accessories as required for complete operational installation.

1.3 SUBMITTALS

A. Product Data: Furnish manufacturer's literature for gate and operator and each manufactured accessory to be provided for Project.

1. Wiring Diagrams: Furnish manufacturer's wiring diagrams for gate operator.
2. Maintenance Data: Furnish manufacturer's operators and parts manual.

B. Shop Drawings: Show location of vertical pivot gates system in relationship with adjacent fencing and paving, details of installation, hardware locations, and accessories.

1. Templates: Provide drawings or templates for installation of anchor bolts in support slab.

C. Certificates: Furnish manufacturer's certification indicating system provided complies with specified requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Firm approved by manufacturer or with minimum five years successful experience completing vertical pivot gate installation similar to that required.

B. Pre-installation Conference: Conduct meeting at site prior to commencing work related to vertical pivot gate system installation.

1. Require attendance of parties directly affecting vertical pivot gate installation.
2. Review site conditions, procedures, and coordination required with related work.

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions and component layout by field measurements prior to beginning installation.

1.6 WARRANTY

A. Provide manufacturer's standard limited warranty for system and system components against failure resulting from normal use based on manufacturer's literature.

1. Failure shall be defined as any defect in manufacturing which prevents gate from operating as intended.

B. Warranty Period: Three years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Safety Devices:

1. Provide manufacturer's standard safety devices including following features.
2. Provide pressure relief valve to avoid crushing obstruction encountered in either direction of travel.
3. Provide shut off power device if balance system fails.

B. Power Failure: Provide manual bypass system, which allows barrier to be opened and to be closed in event of power failure.

C. Operation: Design system to allow for minimum 2900 open and close operations per day.

1. Gate heights up to eight feet, use a standard operator model HYJD-DC-25. Gates that are a total of nine feet tall require an extended operator model HYJD-DC-25E.

D. Gate Height: As indicated.

1. Note: Gate widths from 25 feet wide or up to 50 feet total width for two vertical pivot gate operators are possible with aluminum barriers, up to 40 feet total width for steel barriers, with no center posts, overhead supports, tracks, or special framing required.

E. Gate Width: : As indicated.

F. Configuration: : As indicated.

2.2 MANUFACTURER

A. Basis of Design product and Manufacturer; Ideal Manufacturing, Vertical Pivot Gate System: Ideal Mfg., Inc./TILT-A-WAY Models HYJD-DC-25 and HYJD-DC-25E.

2.3 COMPONENTS

A. Hydraulic Power Unit: 1 HP TEFC motor, 1800 RPM, 24 Volt DC Hydraulic set Hydraulic power unit capable of delivering 4 GPM at 1000 PSI, with external adjustment relief valve and 4-way solenoid operated 3-position manual override valve.

1. Hydraulic pump, motor, and reservoir will be all as one unit with fluid thermometer and fluid level sight gauge.
2. The hydraulic system will be designed to keep the gate locked in the closed position, keeping any person from lifting the gate open when it is in the closed position.
3. Pedestal Frame: Welded construction with removable outer skin of cross break corrosion resistant painted gray .063 aluminum plate panels.
4. Inspection Door Hardware: Stainless steel continuous hinges and heavy-duty lockable pull down catches to hold inspection door shut.
5. Power: 110 Volt AC 24 Volt DC battery back up, 24 Volt DC motor and control board, 110 Volt AC for battery charger and optional accessories. The two12 Volt batteries supplied by installer, or owner. Total gate system requires 20-amp service, with no more than 3% drop in voltage, while gate is in operation. (FOR WIRE SIZE: CONSULT LOCAL ELECTRICAL CODE.)

B. Hydraulic System: 2500 psi hydraulic cylinder.

1. Cylinder: 2-1/2” by 38” stroke hydraulic cylinder with 1-3/8” diameter rod, proximity switches and cushioned slow down on each end of travel, and adjustable stops with lock down in any position.
2. Hydraulic Fluid: Manufacturer’s standard, factory checked, filled, and tested.

C. Balance System: System designed to allow barrier to be hand raised and to be hand lowered with 12 to 15 pounds of pressure, consisting of manufacturer’s standard cables, sheaves, sealed cam yoke roller bearings, and tension springs pulled in a straight line.

1. Safety Control Switch: Provide built-in safety control switch capable of stopping barrier in any position should balance system fail.
2. Testing: Factory test and adjust balance system to ensure gate may be manually raised and lowered with specified pressure.
3. Signage: Signage to be added to the gate barrier must be declared at the time of order so the manufacturer can add the signs on the barrier, to ensure Ideal Mfg. balances the operator correctly at the time of manufacturing

D. Electrical System: Oversized rain tight enclosure housing electrical components except limit switches, safety switches, and motor.

1. Wire: Oil and gasoline resistant.
2. Overload Protection: Allen Bradley type overload protection relay to protect motor.
3. Reversing Controller: Provide as required to operate motor and solenoid valves.
4. Overrun Delay Timers: Integral to board capable of shutting down system in case motor runs longer than 30 seconds.
5. Proximity Switches: Adjustable snap action limit switches capable of stopping barrier at each end of travel.
6. Logic Board: Programmable logic board with manufacturer's full range of available functions.
7. All gates are equipped with a dry contractor to accommodate all types of access equipment.

8. Options:

    a. Cold Weather Package: (Required in areas where the temperature drops to less than 35° F.)
    b. Stanchion: (This is for the free end of gate.)
    c. Radio Controls: Provide standard open–close–stop commercial transmitters/receiver systems.
    d. Loop Detectors: Provide detector system (except loop) To allow free exit/safety, safety or close gate operation; system to be factory wired inside electrical box and tested.
    e. Reversing Edge: Provide manufactures standard reversing edge system.
    f. Synchronizing Box: Master Slave system for paired gate system (required only when 2 gates operate in conjunction with each other.)
    g. Gate Status Lights: Provide light stacks indication gate status: Such as green light indicates barrier is open; red indicates barrier is closed; and flashing amber indicates gate is moving.
    h. Locks: magnetic lock secures gate in closed position.
    i. Photo Eye: Used as a form of safety
    j. S.O.S.: Siren Operated Sensor (Emergency access system)
    k. Snow removal access doors
    l. Stainless steel fasteners
    m. Heater for Electrical Box: Provide heater, including full box insulation to protect system for conditions to minus 70° F.
    n. Ice scrapers (for cable sheaves.)
    o. Access Control Systems:

E. Barrier System (Gates): Design to resist twist and to resist sway.

1. Type: Manufacturer's standard aluminum barrier (up to 25 foot wide opening per gate leaf), nominal 3.125" by 2.875" diamond 6063-T5 alloy aluminum screen fabric (amplimesh) welded both sides completely, with sway bracing. Leading member of an aluminum barrier 4" schedule 40 round tube, sway braces- 1 ¼ x 1 ¼ x 1/8 square tube uprights- 2 x 2 x .188 square tube. Sway braces bolted to barrier.
2. Type: Custom barrier as indicated on Drawings, with sway bracing.
3. Provide stanchion to contain free end for severe crash applications; match barrier.

F. Accessories: Provide as required for complete operational installation.

1. Child Guards: Provide child and small animal guard on secured side of operator.

2.4 FINISHES

A. Finish: Factory prime with DTM epoxy and paint with westhane acrylic urethane to resist corrosion.

1. Color: As selected from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify concrete support slab complies with requirements and verify anchors and conduits are properly installed

1. Ensure alignment with adjacent construction, fencing, and paving; coordinate with adjacent construction.

3.2 INSTALLATION

A. Comply with manufacturer's recommendations and installation instructions.

1. Install vertical pivot gate system to provide rigid and secure installation as indicated, straight and true to lines and levels indicated, for free, easy operation.
2. Install components square and level, accurately fitted and free from distortion and free from defects.

B. Advise Owner regarding programmable features and controls and preset controls according to Owner requirements.

1. Instruct Owner personnel in proper operation, maintenance, and reprogramming of system.

3.3 PROTECTION

A. Protect vertical pivot gate system from damage during remainder of construction operations; replace components damaged by subsequent construction operations.

B. Touch-up scratched and damaged surfaces using same primer and finish system applied in shop.

END OF SECTION 32 31 05

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SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

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. Chain-link fences.
2. Swing gates.
3. Privacy slats.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review coordination of interlocked equipment specified in this Section and elsewhere.
2. Review required testing, inspecting, and certifying procedures.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Fence and gate posts, rails, and fittings.
b. Chain-link fabric, reinforcements, and attachments.
c. Accessories: Privacy slats.
d. Gates and hardware.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, gate operation, and operational clearances.

C. Samples for Initial Selection: For each type of factory-applied finish.

D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

1. Polymer-Coated Components: In 6-inch lengths for components and on full-sized units for accessories.

E. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer and testing agency.

B. Product Certificates: For each type of chain-link fence, and gate.

C. Product Test Reports: For framework strength according to ASTM F1043, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup for typical chain-link fence and gate, including accessories.

a. Size: 10-foot length of fence.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design chain-link fence and gate frameworks.

B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.

1. Design Wind Load: As indicated on Drawings.

a. Minimum Post Size: Determine according to ASTM F1043 for post spacing not to exceed 10 feet for Material Group IA, ASTM F1043, Schedule 40 steel pipe.
b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire for Fabric: Wire diameter of 0.192 inch.

a. Mesh Size: 2 inches.
b. Zinc-Coated Fabric: ASTM A392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied after weaving.

c. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: Knuckled bottom.

2.3 FENCE FRAMEWORK

A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 or ASTM F1083 based on the following:

1. Fence Height: As indicated on Drawings.

2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.

a. Line Post: 2.375 inches in diameter.
b. End, Corner, and Pull Posts: 4.0 inches in diameter.

3. Brace Rails: ASTM F1043.
4. Metallic Coating for Steel Framework:

a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. zinc coating according to ASTM A653/A653M.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch- diameter, marcelled tension wire according to ASTM A817 or ASTM A824, with the following metallic coating:

1. Type II: Zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:

a. Matching chain-link fabric coating weight.

2.5 SWING GATES

A. General: ASTM F900 for gate posts swing gate types.

1. Gate Leaf Width: As indicated.
2. Framework Member Sizes and Strength: Based on gate fabric height as indicated.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; protective coating and finish to match fence framework.
2. Gate Posts: Round tubular steel.

3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded.

D. Hardware:

1. Hinges: 360-degree inward and outward swing.
2. Lockable Latch: Permitting operation from both sides of gate.

2.6 FITTINGS

A. Provide fittings according to ASTM F626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

a. Hot-Dip Galvanized Steel: 0.148-inch- diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

I. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

2.7 PRIVACY SLATS

A. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than 0.06 inch thick, sized to fit mesh specified for direction indicated, with vandal-resistant fasteners and lock strips.

B. Color: As selected by Architect from manufacturer's full range.

2.8 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

2.9 GROUNDING MATERIALS

A. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Concealed Concrete: Place top of concrete 2 inches below grade to allow covering with surface material.
    b. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of as indicated on Drawings. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at 10 feet o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

H. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

N. Privacy Slats: Install slats in direction indicated, securely locked in place.

1. Diagonally for privacy factor of 80 to 85.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GROUNDING AND BONDING

A. Fence and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
2. Install ground rods and connections at maximum intervals of 1500 feet.

3. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
4. Ground fence on each side of gates and other fence openings.

    a. Bond metal gates to gate posts.
    b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

E. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
3. Make above-grade ground connections with mechanical fasteners.
4. Make below-grade ground connections with exothermic welds.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

F. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests.

B. Prepare test reports.

3.7 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION 32 31 13