# PROJECT MANUAL

NMSU NMDA New Office Building

**DPS Project Number: 22-0227.001**

## Volume 2 of 2

Date: 4/29/2024

*50% Construction Documents*

DEKKER PERICH SABATINI

Architecture in Progress

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Las Cruces, NM

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| ARCHITECT | Responsible For Sections: | |
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| | Division 00 | All Sections |
| | Division 01 | All Sections |
| | Division 02 | Section 02 4100 - Demolition |
| | Division 03 | Section 03 3511 - Concrete Floor Finishes |
| | Division 04 | Section 04 7300 - Simulated Stone Veneer |
| | Division 05 | Section 05 5000 - Metal Fabrication |
| | | Section 05 5213 - Pipe and Tube Railings |
| | Division 06 | All Sections |
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| STRUCTURAL | Responsible For Sections: | |
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| | Division 03 | Section 03 0516 – Underslab Vapor Retarder |
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| | | Section 05 4000 – Cold-Formed Metal Framing |

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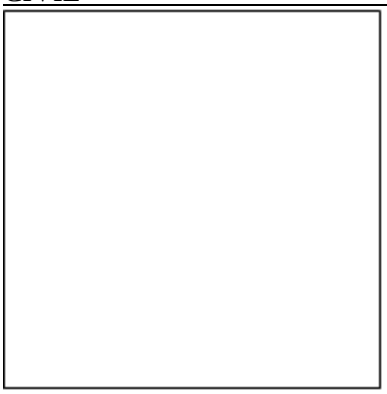
CIVIL

Responsible For Sections:

Division 31 All sections



PLUMBING & MECHANICAL

Responsible For Sections:

Division 21 All Sections
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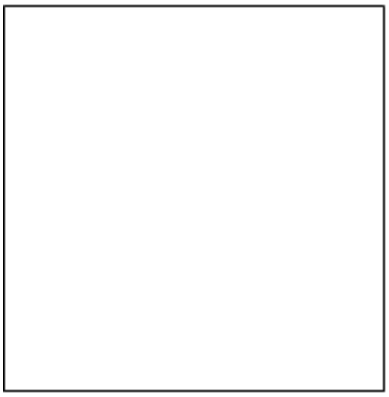

ELECTRICAL

Responsible For Sections:

Division 26 All Sections
Division 27 All Sections
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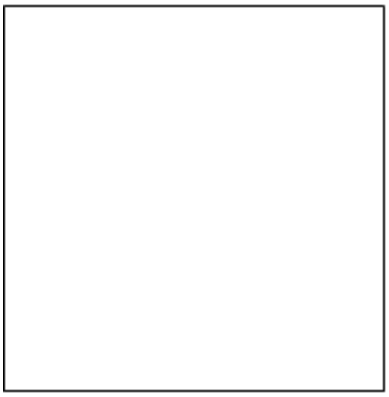

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**COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 - GENERAL

1.1 SUMMARY

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

B. Section includes pipe, fittings, valves, and connections for fire protection systems.

1.2 SUBMITTALS

A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

B. Product Data:

1. Submit manufacturers catalogue information. Indicate valve data and ratings.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. All materials and equipment submitted for use in fire protection systems shall be UL Listed and FM Approved for use in a fire protection application.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and tag numbering.

B. Operation and Maintenance Data: Submit spare parts lists.

1.4 QUALITY ASSURANCE

A. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

B. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

C. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

D. Perform Work in accordance with NFPA 13 standard.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.

B. Furnish cast iron and steel valves with temporary protective coating.

C. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Provide ventilation in areas to receive solvent cured materials.

PART 2 - PRODUCTS

2.1 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. Fire Main Equipment: HAMV - Main Level

a. Indicator Posts, Gate Valve: HCBZ - Level 1
b. Ball Valves, System Control: HLUG - Level 3
c. Butterfly Valves: HLXS - Level 3
d. Check Valves: HMER - Level 3
e. Gate Valves: HMRZ - Level 3

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

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

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
3) Miscellaneous valves.

C. Gate Valves:

1. Up to and including 2 inches: Bronze body and trim, rising stem, hand wheel, solid wedge or disc, threaded ends.
2. Over 2 inches: Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, hand wheel, OS&Y, solid bronze or cast iron wedge, flanged or grooved ends.
3. Over 4 inches: Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends, iron body indicator post assembly.

D. Globe Valves:

1. Up to and including 2 inches: Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity.
2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

E. Ball Valves:

1. Up to and including 2 inches: Bronze two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle, threaded ends.

F. Butterfly Valves:

1. Bronze Body: Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, hand wheel and gear drive and integral indicating device.
2. Cast or Ductile Iron Body: Cast or ductile iron, chrome or nickel plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends. With extended neck, hand wheel and gear drive and integral indicating device.

G. Check Valves:

1. Up to and including 2 inches: Bronze body and swing disc, rubber seat, threaded ends.
2. Over 2 inches: Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends.
3. 4 inches and Over: Iron body, bronze disc with stainless steel spring, resilient seal, threaded, wafer, or flanged ends.

H. Drain Valves:

1. Compression Stop: Bronze with hose thread nipple and cap.
2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.

## 2.2 BURIED PIPING

A. Steel Pipe: ASTM A53/A53M, Grade B or ASTM A795/A795M, Schedule 40 black.

1. Steel Fittings: ASME B16.9, wrought steel, butt welded; ASME B16.5, steel flanges and fittings;.
2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings.
3. Joints: AWS D1.1, welded.

B. Cast Iron Pipe: AWWA C151.

1. Fittings: AWWA C110, standard thickness.
2. Joints: AWWA C111, rubber gasket.
3. Mechanical Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.

## 2.3 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A53/A53M, Grade B; or ASTM A795/A795M; Schedule 40 black.

1. Steel Fittings: ASME B16.9, wrought steel, butt welded; ASME B16.5, steel flanges and fittings; ASME B16.11, forged steel socket welded and threaded.
2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings; ASME B16.4, threaded fittings.
3. Malleable Iron Fittings: ASME B16.3, threaded fittings.
4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
5. Mechanical Formed Fittings: Carbon-steel housing with integral pipe stop and O-ring pocked and O-ring uniformly compressed into permanent mechanical engagement onto pipe.

B. Above Ground Pipe Accessories
1. Escutcheons
   a. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

## 2.4 PIPE HANGERS AND SUPPORTS

A. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

B. Conform to NFPA 13 and NFPA 14.

C. UL Compliance: Comply with UL 203.

D. METAL PIPE HANGERS AND SUPPORTS

1. Carbon-Steel Pipe Hangers and Supports:
   a. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
   b. Galvanized Metallic Coatings: Pre-galvanized or hot-dip galvanized.
   c. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

E. TRAPEZE PIPE HANGERS

1. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

F. METAL FRAMING SYSTEMS

1. MFMA Manufacturer Metal Framing Systems:

a. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
b. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
c. Channels: Continuous slotted carbon-steel channel with inturned lips.
d. Channel Width: Selected for applicable load criteria.
e. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
f. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

G. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.

H. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.

I. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

J. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.

K. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.

L. Vertical Support: Steel riser clamp.

M. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

## 2.5 FIRE DEPARTMENT CONNECTIONS

A. Standard: UL 405.

B. Type: Exposed, projecting; or Flush, for wall mounting.

C. Pressure Rating: 175 psig minimum.

D. Body Material: Corrosion-resistant metal.

E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

F. Caps: Brass, lugged type, with gasket and chain.

G. Escutcheon Plate: Round, brass, wall type.

H. Outlet: Back, with pipe threads.

I. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" or "STANDPIPE" as appropriate.

J. Finish: Polished chrome plated or r; coordinate with Architect.

## 2.6 SLEEVES

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, with plain ends and integral welded waterstop collar.

## 2.7 SLEEVE-SEAL SYSTEMS

A. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Carbon steel.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 of length required to secure pressure plates to sealing elements.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Valves
1. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
2. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
3. Examine threads on valve and mating pipe for form and cleanliness.
4. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
5. Do not attempt to repair defective valves; replace with new valves.

C. Fire Department Connections

1. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
2. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Obtain permission from Architect or Structural Engineer before using powder-actuated anchors.

E. Do not drill or cut structural members.

F. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

G. Remove incompatible materials affecting bond.

## 3.3 INSTALLATION

A. Install piping in accordance with NFPA 13 for sprinkler systems, NFPA 14 for standpipe and hose systems, and NFPA 24 for service mains.

B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping whenever practical at common elevations.

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

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

G. Install pipe sleeve at piping penetrations through partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

I. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.

J. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

K. Do not penetrate building structural members unless indicated.

L. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.

M. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

N. Where inserts are omitted, drill through concrete slab from below and install through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

## 3.4 INSTALLATION – VALVES

A. 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.

B. Install double-check valve assembly in each fire-protection water-supply connection.

C. 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.

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

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

F. Install gate, ball, or butterfly valves for shut-off or isolating service.

G. Install drain valves at main shut-off valves, low points of piping and apparatus.

H. Install valve tags. Comply with requirements in 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.

## 3.5 INSTALLATION – HANGERS AND SUPPORTS

A. General Requirements:

1. Install in accordance with NFPA 13 and NFPA 14.
2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
3. Place hangers within 12 inches of each horizontal elbow.
4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

B. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. 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 A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

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

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

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

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

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

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

## 3.6 INSTALLATION - SLEEVES

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

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

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

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

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

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

3. Using grout or silicone sealant, seal 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.

## 3.7 INTERFACE WITH OTHER PRODUCTS

A. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

## 3.8 CLEANING

A. Clean entire system after other construction is complete.

B. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

# SECTION 21 05 53

# IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

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

B. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

### 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. Material and Thickness: Brass, 0.032 inch, stainless steel, 0.025 inch, aluminum, 0.032 inch, or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. 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.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. 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. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

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

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

D. 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.

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

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

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

## 2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.

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

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

D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Lettering Size: Size letters according to ASME A13.1 for piping.

E. Pipe-Label Colors:

1. Background Color: Safety Red.
2. Letter Color: White.

2.4 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032 inch, stainless steel, 0.025 inch, aluminum, 0.032 inch, or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass wire-link chain.
3. Valve-Tag Color: Safety Red.
4. Letter Color: White.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

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

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of 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 GENERAL 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 identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

## 3.4 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. 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.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

## 3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Fire-Suppression Standpipe: 1-1/2 inches.
b. Wet-Pipe Sprinkler System: 1-1/2 inches.

END OF SECTION

# SECTION 21 13 13

# WET-PIPE SPRINKLER SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Specialty valves.
2. Sprinklers.
3. Alarm devices.
4. Manual control stations.
5. Control panels.
6. Pressure gauges.

### 1.2 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

D. Delegated-Design Submittal: For wet-pipe sprinkler systems 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. Coordination Drawings: Sprinkler systems, or BIM model, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

B. Design Data:

1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

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

PART 2 - PRODUCTS

2.1 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. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.

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

D. Delegated Design: Engage a qualified professional engineer to design wet-pipe sprinkler systems.

E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

## 2.2 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:
1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, and fill-line attachment with strainer.
4. Drip cup assembly pipe drain with check valve to main drain piping.
5. 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.

G. Deluge Valves:
1. Standard: UL 260.
2. Design: Hydraulically operated, differential-pressure type.
3. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.

H. Automatic (Ball Drip) Drain Valves:
1. Standard: UL 1726.
2. Pressure Rating: 175-psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

## 2.3 AIR VENT

A. Manual Air Vent/Valve:
1. Description: Ball valve that requires human intervention to vent air.
2. Body: Forged brass.

3. Ends: Threaded.
4. Minimize Size: 1/2 inch.
5. Minimum Water Working Pressure Rating: 300 psig.

B. Automatic Air Vent:
1. Description: Automatic air vent that automatically vents trapped air without human intervention.
2. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler systems.
3. Vents oxygen continuously from system.
4. Float valve to prevent water discharge.
5. Minimum Water Working Pressure Rating: 175 psig.

C. Automatic Air Vent Assembly:
1. Description: Automatic air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly.
2. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler system.
3. Vents oxygen continuously from system.
4. Float valve to prevent water discharge.
5. Minimum Water Working Pressure Rating: 175 psig.

## 2.4 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:
1. Standard: UL 213.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:
1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.

4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
1. Standard: UL 1474.
2. Pressure Rating: 250-psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:
1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175-psig minimum.
4. Size: Same as connected piping, for sprinkler.

## 2.5 SPRINKLERS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes: Chrome plated, bronze, and painted.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:
1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

## 2.6 ALARM DEVICES

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

B. Electrically Operated Notification Appliances:
1. Electric Bell:

a. Standard: UL 464.
b. Type: Vibrating, metal alarm bell.
c. Size: 6-inch minimum- diameter.
d. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.

2. Strobe/Horn:

a. Standard: UL 464.
b. Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
c. Voltage: 120 V ac, 60 Hz.
d. Effective Intensity: 110 cd.
e. Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."

C. Water-Flow Indicators:
1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

D. Pressure Switches:
1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:
1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. 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.

## 2.7 PRESSURE GAUGES

A. Standard: UL 393.

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

C. Pressure Gauge Range: 0 to 300 psig.

D. Label: Include "WATER" label on dial face.

## PART 3 - EXECUTION

### 3.1 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 210500 "Common Work Results for Fire Suppression" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping.

### 3.2 PIPING INSTALLATION

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

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

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

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

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

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

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

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

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

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

K. Install alarm devices in piping systems.

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

1. Fastener Systems

a. Powder-Actuated Fasteners: **Not Allowed**.
b. Mechanical-Expansion Anchors: Undercut-style anchors suitable for use in both cracked and uncracked hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1) Anchors shall be Hilti Type HAD or Engineer-approved equal.
2) Mechanical expansion anchors shall not be used in lightweight concrete or concrete slabs less than 4 inches thick.
3) Indoor Conditioned Space: Zinc-coated or stainless steel.
4) Indoor Unconditioned Space and Outdoor Applications: Stainless steel.

**2. All hanger rods shall have a double nut above and below the clevis hanger or trapeze structural member and at hanger-rod attachments.**

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

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

O. Fill sprinkler system piping with water.

P. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing.

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

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

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

## 3.3 VALVE AND SPECIALTIES INSTALLATION

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

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

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

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.

E. Air Vent:

1. Provide at least one air vent at high point in each wet-pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.

## 3.4 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels. Coordinate sprinkler head locations in ceilings with Architect.

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

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

## 3.5 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals.

## 3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.

6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

## 3.7 CLEANING

A. Clean dirt and debris from sprinklers.

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

C. Construction Waste: In accordance with Section 01 74 19.

## 3.8 DEMONSTRATION

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

END OF SECTION

# SECTION 22 00 00 - GENERAL PLUMBING REQUIREMENTS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes requirements that expand the requirements specified in Division 01 and applies to all Division 22 – Plumbing Specification Sections. It is the intent of the contract documents to provide an installation complete in every respect. Work shall be executed in a workmanlike manner and shall include all labor, materials, and supervision essential to provide complete functioning systems as described in the contract documents. In the event that additional details or special construction is required for work indicated, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation at no expense to the Owner.

C. Conflict Resolution: Where conflicts may exist between the minimum requirements of various laws, codes, authorities, and/or within the Contract Documents, the higher quality, greater quantity, more restrictive and/or more expensive requirement shall be the basis of Contractor pricing and the Contractor shall notify the Architect/Engineer and Owner’s Representative for the resolution of the issue prior to executing the work in question.

D. Should any errors, omissions, conflicts, or ambiguities exist in the drawings, the Contractor shall bring these to the attention of the Engineer immediately for adjustment in writing before signing the contract or proceeding with the work. Otherwise, he shall at his own expense, supply the proper materials and labor to make good any damage or defect caused by such unintentional error.

E. Contractor is responsible for checking all contract documents, field conditions and dimensions for accuracy, and confirming that the work is buildable as shown and meets all applicable codes before proceeding with construction. If there are any questions regarding these or other coordination issues, the Contractor is responsible for obtaining a clarification from the Architect/Engineer before proceeding with the work in question or related work.

F. Contractor shall direct all questions to the Owner's project coordinator. The Contractor shall verify all working conditions such as starting time, noise and vibration limitations, confined space, etc. Through the project coordinator and approval shall be received to start work.

G. Related Sections:

1. Drawings, Contract, including General and Supplementary Conditions, and Division 01 – General Requirements Specification Sections apply to this and all other Division 22 – Plumbing Specification Sections.

H. Deviations to the intended design or the scope of the work must be approved by the project Engineer prior to commencing work. Failure to do so may result in the work to be removed at no cost to the Owner.

I. All work shall be performed in accordance with all applicable local codes, standards, and amendments and/or other authorities that may have jurisdiction pertaining to the work. In addition, all work shall conform to the standards and practices of the Owner, where applicable.

J. Coordination:

1. The Contractor shall be responsible for ensuring full coordination with other trades and Contractors to accomplish the work as shown and noted in these contract documents. The Contractor shall compare the drawings of other trades and report any discrepancies to the Owner's representative.
2. The Contractor shall not fabricate or install items as shown on the drawings if there are discrepancies or conflicts between the existing conditions and the information shown on the drawings until such discrepancies have been resolved. Prior to fabrication or installation, the Contractor shall immediately call such discrepancies or conflicts to the attention of the project coordinator.
3. Ductwork, piping, conduit, cabling, etc. shown on drawings shall be coordinated with air distribution devices, special ceiling, floor, and structure construction, etc. Provide additional rises and drops to those indicated on the drawings as required to coordinate with architectural, structural or MEP elements shown on the contract documents. All utilities shall be routed in an orderly manner, grouped together wherever possible, and located so as to conserve building space. Ductwork, piping, conduit, cabling, etc. Shown on each plan is run above the ceiling on the floor where it is shown unless otherwise noted.
4. Refer to civil-site drawings for buried pipe trenching and backfill specifications and details.

K. As-Builts: The Contractor shall maintain his set of construction drawings on site at all times so that all changes between the drawings and the actual construction can be noted on the drawings. This includes all deviations from the original contract. The Contractor shall indicate all changes from the original plans made during the installation of his work in red ink on two blueline prints. At the end of construction, the Contractor shall sign and date the drawings certifying that they are an accurate reflection of the actual construction. As-built drawings are to be delivered to the Owner's project coordinator after project completion. Note that the final invoice for the contract will not be paid by the Owner until final as-built drawings are received.

L. All work noted "NIC" or "Not in Contract" is to be accomplished by another Contractor and is not to be part of the construction agreement.

## 1.2 DEFINITIONS

A. Furnish: To purchase and deliver products to the project site and prepare for installation.

B. Install: To assemble, erect, secure, connect, and place furnished product into operation.

C. Provide: To furnish and install.

D. Products: Includes materials, systems, parts, and equipment.

E. Concealed: Embedded in or installed behind walls, within partitions, above suspended ceilings, in trenches, in tunnels and crawl spaces.

F. Exposed: Not installed underground or "concealed" as defined above.

G. Specifications: These specifications plus the Codes and Standards referenced herein.

## 1.3 CONTRACTOR QUALIFICATIONS

A. General: The firms that perform the installation of the work under this Division of specifications shall be one that maintains an established, experienced organization with a permanent, manned office within a radius of 150 miles of Round Rock, Texas.

B. Plumbing Firm’s Proficiency: The firm's proficiency in the installation, start up, adjustment and maintenance of plumbing systems shall have been demonstrated by the successful performance of work as specified herein on at least three systems with wall or floor mounted flush valve water closets, primary and secondary roof drainage systems, and 2 inch minimum domestic water service with reduced pressure zone backflow prevention protection. The firm shall have trained personnel, instruments, tools, and equipment to perform the installation and maintenance service specified. The firm shall have been in business performing services as specified herein for at least three years.

## 1.4 SAFETY:

A. Contractor shall comply with all applicable safety standards including, but not limited to OSHA standards and Owner’s requirements.

B. All safety exposures or violations shall be rectified immediately by the Contractor. The Contractor shall be responsible for providing protection of persons and property, providing safe working conditions throughout the work progress, providing temporary coverings for openings through walls or floors, and providing temporary barriers, partitions and/or dust barriers where required to maintain OSHA and the Owner's safety standards and to prevent damage to property. All areas adjacent to the construction area or affected by the construction must be protected from damage, cleaned, and restored to the original condition at no additional expense to the Owner. The Contractor shall provide protective clothing and eyewear for all personnel who are required to handle hazardous chemical products or work in hazardous locations.

C. Submit material safety data sheets and manufacturer's current recommended method of installation for all materials used to perform the work indicated by these documents. All

submittals shall be prepared according to current Owner specifications and shall be approved prior to starting any work. All chemicals or chemical compounds proposed for use on the property including, but not limited to paint thinners, solvents, adhesives, sealants, cleaning compounds, epoxies, etc. Must be approved by the Owner.

D. Dispose of debris, trash, and hazardous materials in accordance with all applicable codes.

E. The Contractor shall be responsible for training his/her employees and subcontractors as required by the Owner, and in the recognition and avoidance of unsafe conditions, and in the regulations and hazards which apply to the area in which the work will take place.

F. Work areas shall be kept continuously, at all times, free of debris and non-hazardous material to the satisfaction of the project coordinator. All existing piping and conduits shall have temporary protection during construction. The Contractor shall coordinate storage of materials, parking of vehicles, and restrictions of work with the project coordinator. After project completion, the site shall be cleaned up and restored to its condition or better prior to the start of the project to the satisfaction of the project coordinator.

## 1.5 QUALITY CONTROL

A. Comply with manufacturers' instructions, including each step in sequence.

B. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

D. Conform to reference standard by date of issue current on date of Contract Documents date for receiving bids, except where a specific date is established by code.

## 1.6 SUBMITTALS

A. Contractor shall provide product data submittals on all major equipment, components, and materials specified in these plans for Engineer's and Owner's review and acceptance prior to installation. ALL submittals shall be in .pdf format.

B. Contractor Review: The Contractor shall check data carefully to insure compliance with these specifications prior to submitting. For product data describing two or more variants of the same model product, clearly mark the selected product and all included accessories and options. Stamp and sign each submittal section indicating review and approval and provide notes indicating any variances that exist.

C. Submittal data for Section 22 00 00 – General Plumbing Requirements:

1. Electrical Requirements List: Provide a list indicating the electrical requirements for each piece of plumbing equipment. The list shall include all of the information shown on the sample list at the end of this Section. All of the information contained in the sheet shall be coordinated between the plumbing and electrical Contractors so that the data reflects actual requirements for the submitted plumbing equipment. Submittals for electrically powered equipment shall not be reviewed until this sheet is received by the Engineer completed and signed. See sample Electrical Requirements List at the end of this Section.
2. Coordination Drawings: Indicate the proposed locations of equipment, ductwork, piping, and materials by preparing floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. The sheet metal drawing shall be the Base Sheet. Other drawings produced shall be coordination drawing overlays, so interferences can be detected. Prepare coordination drawings to a scale of 1/4" = 1'-0" or larger clearly indicating the following:

    a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
    b. Clearances for installing and maintaining insulation.
    c. Clearances for installing and maintaining valves, dampers, and their actuators.
    d. Equipment connections and support details.
    e. Exterior wall and foundation penetrations.
    f. Fire-rated wall and floor penetrations.
    g. Sizes and location of required concrete pads and bases.
    h. Indicate locations where space is limited for installation and maintenance.
    i. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
    j. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
    k. Fire Protection drawings shall be coordinated with other trades.

D. Submittal data for other Division 22 Specification Sections: Provide data as required in each individual Division 22 Specification Sections. Submittal data types are as follow:

1. Compliance Data: Published literature, certificates, and lists indicating the product's compliance with standards referenced in these specifications.
2. Published Literature: Indicate dimensions, weights, capacities, ratings, horsepower, gages, and finishes of materials, and electrical characteristics and connection requirements.
3. Performance Data: Performance data including fan curves, pump curves, and equipment output capacities complete with rating conditions as scheduled on contract drawings. As a minimum submitted data shall include all performance data scheduled or noted on contract drawings.
4. Sound Power Level Data: Equipment sound power level at 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz octave band center frequencies plus db A weighted sound level. Data shall include distance from equipment to test equipment.
5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

6. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
7. Manufacturer's Instructions: Include installation instructions.
8. Certificates: Signed letters certifying compliance with specified requirements.
9. Calculations: Design and/or design calculations.

E. Shop drawings: all shop drawings, including product data submittals, shall be reviewed by the Contractor prior to submitting to the Engineer. All shop drawings not reviewed by the Contractor will be returned without review. After review has been completed, submit a copy of each shop drawing to the Owner with the approval seal of the Engineer and the Contractor. The use of reproductions of these contract drawings by any Contractor, subcontractor, erector, fabricator or material supplier, in lieu of the preparation of shop drawings is forbidden. Shop drawings received bearing the Engineer's title and seal shall be promptly rejected.

## 1.7 SUBSTITUTIONS

A. Basis of Design: Model numbers indicated in other Division 22 Specification Sections or shown on the drawings are the Basis of Design. The Contractor may request substitution of equal and approved equipment from manufacturers listed in this specification or set forth in an addendum provided said equipment meets all requirements of the plans and specifications, has like electrical characteristics (e.g., same voltage, phase, fusing/circuit breaker requirements, single or multiple points of connection as indicated on the electrical drawings), and will fit in the available spaces in the building as shown. Substitutions must be requested a minimum of 10 days before bids are due, as described below.

B. If the Contractor chooses to provide equipment which meets all of the aforementioned requirements, but has different electrical characteristics, he shall bear all costs associated with that substitution including, but not limited to, breakers, fuses, disconnects, wiring, conduits, panels, starters, contactors, and the like. All electrical connections shall be coordinated with the Engineer and with the electrical subcontractor.

C. Substitutions: Substitutions of specified items will be considered until 10 days prior to bid opening. Each request shall include a description of the proposed substitute, the name of material or equipment for which it is to be substituted, drawings, cuts, performance and test data for an evaluation and a statement from the equipment manufacturer's representative that the items to be substituted meet or exceed the specifications of the item substituted for.

1. A request for substitution constitutes a representation that the Contractor:

   a. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
   b. Will provide the same warranty for the Substitution as for the specified Product.
   c. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
   d. Waives claims for additional costs or time extension which may subsequently become apparent.
   e. Will reimburse Owner [and Architect/Engineer] for review or redesign services associated with re-approval by authorities.

2. The Engineer will notify Contractor in writing of decision to accept or reject request.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver Products to the project in manufacturer's original shipping packaging, properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Acceptance at Site: Comply with the following requirements:

1. Inspect shipments and immediately report any damage to the carrier and to the Construction Manager so that job progress will not be delayed.
2. All items received by the Contractor shall be left in their original containers, or as shipped with dust caps, packing materials, and weather proof covers until installed in final locations.

C. Storage and Protection: During construction maintain all delivered materials and equipment in an orderly manner and protect from damage by complying with the following minimum requirements:

1. Products stored outside or in unheated spaces shall be covered with waterproof drop cloths or tarpaulins, and provided with blocking to raise the base of each item at least 6 inches above ground and water levels.
2. Store electrical items that would be damaged by cold weather or condensation in a heated, enclosed space until placed into service.
3. Products stored inside shall be protected from dirt, construction debris, welding and cutting spatters, paint dropping etc. either by original packaging or Contractor provided covers.
4. All installed materials and equipment shall be in a like new condition. Damaged equipment or materials shall be repaired to like new conditions or replaced at no cost to the Owner.

## 1.9 SEQUENCING AND SCHEDULING

A. Carefully examine the drawings and specifications of all other trades. Coordinate all work with other disciplines to avoid conflicts and delay of installation schedule.

B. The Contractor shall install plumbing work so as not to interfere with the work of other disciplines or trades. If work is installed that does interfere, the work shall be corrected at no additional cost to the Owner. Occupation of a work space by any trade or discipline does not give the right of priority to the space.

C. Tests: Test requirements shall be as specified in other Division 22 Specification Sections. Provide the Owner’s Rep and Engineer 48 hours notification in advance of any test. Engineer, at his option, may witness test. Complete tests prior to insulating or otherwise covering work. Leaks shall be repaired, defective materials replaced, and system shall be retested. Conduct test prior to connecting to equipment or isolate equipment from system.

## 1.10 UTILITY CONNECTIONS AND PERMITS

A. Natural Gas: Make arrangements with the gas utility company to provide new meter set, tap, and service from main to meter as applicable.

B. Water: Make arrangements with the water utility company to provide water service and meter as shown on site plan as applicable.

C. Sanitary Sewer: Make arrangements with the sewer utility for new sewer tap and service as applicable.

D. The Contractor shall be responsible for securing and paying for all permits, licenses, clearances and certificates from the Owner and local authorities having jurisdiction as required prior to the commencement of the work.

E. Prior to any cutting or trenching, verify with Owners rep., utility companies, and landlord that all available information is known regarding underground obstructions. Take caution when trenching not to disturb any existing utilities. Notify Owners representative immediately upon uncovering unknown utilities for further direction.

## 1.11 COMPLETION OF WORK

A. Execute final cleaning prior to final inspection.

B. Final Cleaning: Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

C. Clean construction debris from roof.

D. Remove waste and surplus materials, rubbish, and construction facilities from the site.

E. Contractor to provide start-up and commissioning services for all new systems and equipment, as well as training services for the Owner's maintenance personnel in the use of these systems and equipment. Adjust operating products and equipment to ensure smooth and correct operation.

F. At the completion, an inspection shall be made and the entire system shall be shown to be in specified working condition. The following shall be available during the inspection:

1. Owner's Representative.
2. Contractor representative.
3. Mechanic with hand tools, ladder and flash light.
4. Complete specifications and drawings with all addenda and revisions.

## 1.12 GUARANTEE AND WARRANTIES

A. Warranties: Provide manufacturer's equipment warranties prior to final inspection. Length of warranty period shall be as specified in individual Division 22 Specification Sections.

B. Guarantee: All equipment and materials furnished and all work performed under this Division of specifications shall be guaranteed to be free of defective materials and workmanship for a period of one year from the date specified in A above. Upon notice from the Owner of failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts shall be promptly replaced with new parts by the Contractor at no additional cost to the Owner. All labor required to perform guarantee shall be included as part of the complete guarantee warranty.

## 1.13 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, Product Data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Contract Close-Out Record Documents: Prepare construction record documents indicating the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located, concealed unions located, locations of flexible pipe connectors, expansion joints, anchors, and guides, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Indicate actual inverts and horizontal locations of underground piping. Record actual locations of storage tanks, fire extinguishing components and equipment, equipment identification markings, conduit and piping routing details.
2. Equipment locations (exposed and concealed), identification, dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

## 1.14 MAINTENANCE DOCUMENTS AND INSTRUCTIONS

A. Maintenance Training: After placing systems in operation, provide 2 members of Owner’s maintenance staff with 4 hours of operation and maintenance training for all systems included in this Section of specifications.

B. Maintenance Manuals: Operating and Maintenance Manuals shall be prepared by the Contractor and submitted in .pdf format to the Engineer and Owner for approval. Each manual shall contain the following information, data and drawings:

1. List of contents. Insert under front cover.
2. Copy of approved submittals, equipment, and materials.
3. Installation, operating, and maintenance instructions for each item of equipment.
4. Wiring schematics for each item of equipment.
5. Manufacturer's list of renewal parts for each item of equipment with recommended stock items and quantities indicated.
6. Manufacturer's equipment warranties.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

## 3.1 ASBESTOS

A. No asbestos containing materials shall be used in any of the new construction.

## 3.2 DEMOLITION

A. General: Provide demolition of existing plumbing work in remodeled areas of the existing building and as described on the drawings. Dispose of removed equipment and materials in a way to maximize recycling content. In addition to work indicated on drawings, demolition includes, but is not necessarily limited to, the following:
   1. Removal of all abandoned piping, supports, equipment, control wiring, etc.
   2. Capping and plugging of piping where demolition begins.

B. Salvage Equipment and Materials: Existing equipment and materials designated for salvage back to the Owner or reinstallation shall be tested for proper operation prior to removal from its installed location. After removal, salvage equipment found defective shall be removed from the Owner's property at no extra cost to the Owner. Salvage equipment found in good working order shall be turned over to the Owner's agent. Defective equipment designated for reinstallation shall be repaired or replaced per bid alternate pricing for repair/replace of existing equipment. Equipment found in good working order, or repaired, and scheduled for reinstallation shall be cleaned, serviced, and stored at Contractor's expense until it is again installed in the building.

## 3.3 ROUGH-IN

A. Final Locations: Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Coordinate plumbing systems, equipment, and materials installation with other building components.

B. Prepare for Installation: Arrange for chases, slots, and openings in other building components during progress of construction, to allow for plumbing installations. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

C. Deviation From Drawings: Drawings are schematic and show approximate location of equipment and materials, however, the Contractor shall obtain the Engineer's/Architect's approval before deviating from the drawings. Written dimensions shall take precedence over scaled dimensions.

## 3.4 PLUMBING INSTALLATIONS

A. General: Installation shall be as specified in individual Division 22 Specification Sections and in accordance with approved manufacturer's installation instructions. Conflict between manufacturer's printed instructions and these specifications shall be brought to the attention of the Engineer/Architect.

B. Equipment: All equipment installed on this project shall be new and unused unless noted otherwise. The Contractor shall remove all shipping labels, dirt, paint spots, grease, and stains from all equipment. Debris shall be removed as it accumulates. Upon completion of his work, the Contractor shall clean all equipment. No loose parts or scraps of equipment shall be left on the premises.

C. Installation: Install systems, materials, and equipment to conform to approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

1. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
2. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
3. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
4. Install systems, materials, and equipment level and plumb parallel and perpendicular to other building systems and components, following the building lines, where installed exposed in finished spaces.
5. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
6. Provide access panels or doors where units are concealed behind finished surfaces.
7. Install isolation valves at all cold and hot water piping branch taps.

D. Cleaning: Comply with the following cleaning requirements:

1. Upon completion of installation, piping, ducts, and equipment shall be thoroughly cleared of dirt, grease, rust and oil, primed where necessary, and left ready for painting. Vacuum clean the inside and outside of plenums and equipment cabinets.
2. Clean gages, thermometers, traps, strainers, fittings, and lavatory aerators.

E. Painting and Finishing: Comply with the following finishing requirements:

1. Contractor shall clean, spot prime with zinc chromate and entirely repaint, with original color any factory finished equipment which has rusted or been damaged.
2. Insulation coverings shall be cleaned, sized if necessary, and left ready for service identification.
3. Ferrous metal shall be cleaned and primed, ready for painting.

F. Lubrication and Packing: Comply with the following requirements:

1. Lubricate equipment with correct grade, type, and quantity of lubrication before placing equipment into service. Damages caused by not providing proper lubrication shall be repaired at Contractor's expense.
2. Each shaft or valve stem containing a packing gland shall be checked for condition and examined for proper grade, amount, and type of packing by backing packing gland off.
3. Maintain all lubrication and packing seals during construction, and assure that all are operating properly at the time of final acceptance. Replace worn gaskets and packing.
4. When filling systems initially for hydrostatic pressure tests, adjust valve packing glands to finger tight, and allow packing to absorb water for five minutes prior to tightening packing nuts.
5. All rotating pieces of equipment shall be properly lubricated prior to start-up. Damage to shafts, bearings, seals, etc., caused by lack of proper lubrication or over lubrication shall be repaired by the Contractor at no cost to the Owner.

## 3.5 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 – General Requirements. In addition to the requirements specified in Division 01 Specification Sections, the following requirements apply:

1. In new construction areas, avoid cutting of concrete, masonry, and other finished work by use of sleeves and inserts.
2. Any cutting thru structural members or floors shall first be coordinated with the structural Engineer.
3. Cut holes through concrete, brick, tile, etc., when necessary, by rotary core drilling.
4. During cutting and patching operations, protect adjacent installations.
5. Perform at no expense to the Owner, cutting, fitting, and patching of plumbing equipment and materials required to:

    a. Uncover Work to provide for installation of ill-timed Work.
    b. Remove and replace defective Work.

c. Remove and replace Work not conforming to requirements of the Contract Documents.
d. Remove samples of installed Work as specified for testing.
e. Install equipment and materials in existing structures.
f. Upon written instructions from the Engineer, uncover and restore Work to provide for Architect's/Engineer's observation of concealed Work.

6. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
7. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
8. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched. Repaired or patched surface finishes and components will match existing finishes. Use new materials.
9. All new wall and floor penetrations shall be made at 90 degree angles, unless shown otherwise, and shall be sealed fireproof with an approved sealant. All penetrations through fire-rated construction shall be sealed with UL 1479 listed through-penetration firestop systems.
10. All roof penetrations are to comply with Owners roofing Contractors and/or roofing insurance requirements.

## 3.6 EXCAVATION, TRENCHING AND BACKFILL

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The Plumbing subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc. All exterior lines shall be installed with a minimum cover of 24", unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.

2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used. Bell holes for lead pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room for caulking. Bell holes

for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole. Special pipe beds shall be provided as specified hereinafter.

3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6" below the trench depths specified. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.

5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.

6. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.

7. Trenches for cast iron drain, storm water and sewer lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.

8. All surplus materials removed in these trenching operations becomes the property of the Contractor, and shall be disposed of at the expense of the Contractor, at a legal disposal site, off of the campus.

B. Backfilling:

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1 1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.

C. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

D. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of same. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

## 3.7 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

## 3.8 SAMPLE SUBMITTAL FORMS

A. Sample Electrical Coordination Form

SAMPLE
CONTRACTOR COMPANY NAME
HVAC/ELECTRICAL DATA SHEET or PLUMBING/ELECTRICAL DATA SHEET
JOB TITLE
JOB LOCATION

| Nameplate Data (Mechanical/Plumbing Contractor to provide this portion) | | | | | | Electrical Power Distribution (Electrical Contractor to provide this portion) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Unit Tag | Volts | Phase | Minimum circuit amps, KW, or HP | MOCPD* (maximum over current protective device) | Maximum fuse size (if req'd) | Panel Tag | Circuit Number | Circuit Breaker Amps and Poles** | Integral Disconnect Yes or No |
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* MOCPD as listed per equipment manufacturer submittal data

** Must comply with equipment manufacturer submittal data

Plumbing Contractor Name & Signature: _____

Electrical Contractor Name & Signature: _____

General Contractor Name & Signature: _____

**END OF SECTION**

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# SECTION 22 05 03 - PIPES & TUBES FOR PLUMBING

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes: Pipe and pipe fittings for the following systems:
1. Domestic water piping, within 5 feet of building.
2. Sanitary sewer piping, within 5 feet of building.
3. Storm water piping, within 5 feet of building.
4. Equipment drains and over flows.
5. Unions and flanges.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.3 - Malleable Iron Threaded Fittings.
3. ASME B16.4 - Gray Iron Threaded Fittings.
4. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
5. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
6. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
7. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
8. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
9. ASME B31.9 - Building Services Piping.
10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.

B. ASTM International:
1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
4. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
5. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
6. ASTM A536 - Standard Specification for Ductile Iron Castings.
7. ASTM B32 - Standard Specification for Solder Metal.
8. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
9. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
10. ASTM B75 - Standard Specification for Seamless Copper Tube.
11. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
12. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.

13. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
14. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
15. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
16. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
17. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameters.
18. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
19. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
20. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
21. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
22. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
23. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
24. ASTM F628 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core.
25. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
26. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society:
   1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
   2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:
   1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
   4. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.

E. Cast Iron Soil Pipe Institute:
   1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

1.3 SUBMITTALS

A. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.

B. Welders' Certificate: Include welders' certification of compliance with ASME Section IX.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

B. All pipe and fittings must be domestically made. Each fitting shall be stamped as specified by ASME/ANSI B16.3, B16.4, B16.5, B16.9, B16.11, B16.18, or B16.22 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random. Fittings which have been machined, remarked, printed or otherwise produced domestically from non-domestic forgings or materials will not be acceptable. Each fitting to be marked in accordance with MSS SP 25.

C. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or A-105-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges shall not be used. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Allthread rods will not be an acceptable for flange bolts. Bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and rated at least ANSI Grade I.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.7 COORDINATION

A. Coordinate installation of buried piping with trenching.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING

A. Copper Tubing: ASTM B88, Type L, hard drawn.
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.

2. Joints: ASTM B32, or Alloy Grade Sn95 tin-silver, lead free solder.

2.2 SANITARY AND STORM SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.
1. Fittings: PVC, ASTM D2729.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.3 SANITARY AND STORM SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hub-less, service weight.
1. Fittings: Cast iron, CISPI 301.
2. Joints:
a. CISPI 310,
b. Neoprene gaskets and stainless-steel clamp-and-shield assemblies.
c. 4-band worm clamps

2.4 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tubing: ASTM B88, Type L drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: ASTM B32, or Alloy Grade Sn95 tin-silver, lead free solder.

2.5 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with soldered.
3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:
1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION - ABOVE GROUND PIPING

A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not accessible.

H. Install non-conducting dielectric connections wherever jointing dissimilar metals.

I. Slope piping and arrange systems to drain at low points.

J. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

K. Install piping penetrating roofed areas to maintain integrity of roof assembly.

3.3 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

A. Install domestic water piping system in accordance with ASME B31.9, local codes and authority having jurisdiction.

3.4 INSTALLATION - SANITARY WASTE AND VENT AND STORM DRAIN PIPING SYSTEMS

A. Install sanitary waste and vent piping systems in accordance with local plumbing code.

B. Establish invert elevations, slopes for drainage to 1/4 inch per foot minimum. Maintain gradients.

C. Support cast iron drainage piping at every joint.

D. Install bell and spigot pipe with bell end upstream.

3.5 FIELD QUALITY CONTROL

A. Test plumbing piping system in accordance with applicable code.

B. Test for Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.9.

3.6 CLEANING

A. Clean and disinfect domestic water distribution system prior to final completion.

B. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

# SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Gate valves.
2. Ball valves.
3. Butterfly valves.
4. Check valves.

### 1.2 REFERENCES

A. ASTM International:
1. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
2. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

B. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

B. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

### 1.5 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install valves underground when bedding is wet or frozen.

1.8 WARRANTY

A. Furnish one year manufacturer warranty for valves excluding packing.

**PART 2 PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers:
1. Crane Valve, North America.
2. Hammond Valve.
3. Milwaukee Valve Company.
4. NIBCO, Inc.
5. Stockham Valves & Fittings.
6. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

2.2 GATE VALVES

A. Gate Valves for Domestic Water Service, 2-1/2 inches and Larger: MSS SP 70, Class 125, cast iron body, bronze trim, bolted bonnet, non-rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.3 BALL VALVES

A. Ball Valves for Domestic Water Service, 2 inches and Smaller: MSS SP 110, Class 150, bronze, three piece body, chrome plated bronze ball, full port, teflon seats, blow-out proof stem, solder or threaded ends, lever handle.

2.4 BUTTERFLY VALVES

A. 2-1/2 inches and Larger: MSS SP 67, Class 150.
1. Body: Cast or ductile iron, wafer or lug ends, stainless steel stem, extended neck.
2. Disc: Nickel-plated ductile iron or stainless steel.
3. Seat: Resilient replaceable EPDM.
4. Handle and Operator: Infinite position lever handle with memory stop. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.5 CHECK VALVES

A. Horizontal Swing Check Valves:
   1. 2 inches and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N disc, solder or threaded ends.
   2. 2-1/2 inches and Larger: MSS SP 71, Class 125, cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.

B. Spring Loaded Check Valves:
   1. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.
   2. 2-1/2 inches and Larger: MSS SP 71, Class 125, waferstyle, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

**PART 3 EXECUTION**

3.1 EXAMINATION

A. Verify piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

D. Install valves with clearance for installation of insulation and allowing access.

E. Provide access where valves and fittings are not accessible.

3.3 VALVE APPLICATIONS

A. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.

B. Install ball, butterfly, or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install butterfly or globe valves for throttling, bypass, or manual flow control services.

D. Install spring loaded check valves on discharge of water pumps.

E. Install check valves on discharge of pumps in pumped sanitary piping.

F. Install ball and gate valves in domestic water systems for shut-off service.

G. Install ball valves in domestic water systems for throttling service.

3.4 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

# SECTION 22 05 29 - HANGERS/SUPPORTS FOR PLUMBING PIPES AND EQUIPMENT

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.

4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

1.3 SUBMITTALS

A. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

1.4 QUALITY ASSURANCE

A. Surface Burning Characteristics: Maximum 25/50 flame spread/smoke developed index when tested in accordance with ASTM E84.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
1. Anvil International.
2. Cooper Industries.
3. Hilti.
4. PHD Manufacturing.
5. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Plumbing Piping - DWV:
1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.

7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

C. Plumbing Piping - Water:
1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, Carbon-steel ring.

## 2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

## 2.3 INSERTS

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

## 2.4 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:
1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

A. Sleeves for Pipes Through Floors: SCH 10 or 40 galvanized steel pipe with welded water stop ring.

B. Sleeves for Pipes Through Walls: 18 gage thick galvanized steel.

C. Sealant: Acrylic.

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems.
3. Midland Ross Corporation, Electrical Products Division.
4. Unistrut Corp.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.8 PIPE SHIELDS

A. Provide pipe shields for piping 2 inches and smaller fabricated of 20 gauge galvanized steel over insulation in 180 degree segments, minimum 12-inches long.

B. Provide pipe shields for piping 2-1/2 inches and larger fabricated of galvanized steel over insulation in 180 degree segment as follows:

| Pipe Size | Metal Gauge | Shield Length |
|---|---|---|
| 2-1/2 to 6 inches | 18 | 12 inches |
| 8 to 16 inches | 16 | 18 inches |
| 18 inches and larger | 12 | 24 inches |

C. Provide high density segment of insulation at shields at least two inches longer than shield. Foamglas blocks (HLB 1600), phenolic foam segments, polyurethane segments, or polyisocyanurate segments are acceptable for most pipe sizes. High density insulation segment shall be of sufficient compressive strength to prevent indentation of insulation jacket. Submit data indicating compressive strength of insulation segment. Furnish vapor barrier and sealant where used on low temperature service (below 100°F).

D. Secure insulation shields to insulation jacket with adhesive as recommended by insulation manufacturer or 2 stainless steel bands, 1/2 inch wide by 0.015 inch thick with matching seals

## PART 3 EXECUTION

### 3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

### 3.2 PREPARATION

A. Do not drill or cut structural members.

### 3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

### 3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME 31.9.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for copper piping.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Provide clearance in hangers and from structure and other equipment for installation of insulation.

3.5 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor drains watertight to adjacent materials.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 2 inch above finished floor level. Caulk sleeves.

E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with stuffing insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install stainless steel escutcheons at finished surfaces.

3.7 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.8 PIPE SUPPORT SCHEDULES

A. Spacing and capacities are based on water filled pipe. Closer hanger spacing may be required where additional valves and fittings increase the load.

B. Copper and Steel Pipe Hanger Spacing:

| PIPE SIZE Inches | COPPER TUBING MAXIMUM HANGER SPACING Feet | STEEL PIPE MAXIMUM HANGER SPACING Feet | COPPER TUBING HANGER ROD DIAMETER Inches | STEEL PIPE HANGER ROD DIAMETER Inches |
|---|---|---|---|---|
| 1/2 | 5 | 7 | 3/8 | 3/8 |
| 3/4 | 5 | 7 | 3/8 | 3/8 |
| 1 | 6 | 7 | 3/8 | 3/8 |
| 1-1/4 | 7 | 7 | 3/8 | 3/8 |
| 1-1/2 | 8 | 9 | 3/8 | 3/8 |
| 2 | 8 | 10 | 3/8 | 3/8 |
| 2-1/2 | 9 | 11 | 1/2 | 1/2 |
| 3 | 10 | 12 | 1/2 | 1/2 |
| 4 | 12 | 14 | 1/2 | 5/8 |
| 5 | 13 | 16 | 1/2 | 5/8 |
| 6 | 14 | 17 | 5/8 | 3/4 |
| 8 | 16 | 19 | 3/4 | 3/4 |
| 10 | 18 | 22 | 3/4 | 7/8 |
| 12 and Larger | 19 | 23 | 7/8 | 1 |

C. Plastic and Cast Iron Pipe Hanger Spacing:

| PIPE MATERIAL | MAXIMUM HANGER SPACING Feet | HANGER ROD DIAMETER Inches |
|---|---|---|
| ABS (All sizes) | 4 | 3/8 |
| FRP (All Sizes) | 4 | 3/8 |
| Cast Iron Bell & Spigot (Note 2) | 5 | Same as Steel Pipe |
| PVC, CPVC, PP, PVDF (All Sizes) | 4 | 3/8 |
| Glass | 4 | 1/2 |

D. Note 1: Refer to manufacturer’s recommendations for grooved end piping systems.

E. Note 2: Minimum of one hanger for each pipe section close to joint behind bell. Provide hanger at each change of direction and each branch connection.

3.9 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

# SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Tags.
   2. Pipe markers.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME A13.1 - Scheme for the Identification of Piping Systems.

B. National Fire Protection Association:
   1. NFPA 99 - Standard for Health Care Facilities.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog literature for each product required.

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

### 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

### 1.5 QUALITY ASSURANCE

A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.

B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

## PART 2 PRODUCTS

### 2.1 TAGS

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

B. Metal Tags:
   1. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

C. Tag Chart: Typewritten letter size list of applied tags and location plastic laminated.

2.2 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

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

**PART 3 EXECUTION**

3.1 PREPARATION

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

3.2 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install tags using corrosion resistant chain. Number tags consecutively by location.

D. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

E. Identify valves in main and branch piping with tags.

F. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

**END OF SECTION**

# SECTION 22 07 00 - PLUMBING INSULATION

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Plumbing piping insulation, jackets and accessories.
2. Plumbing equipment insulation, jackets and accessories.

### 1.2 REFERENCES

A. ASTM International:
1. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
2. ASTM C552 – Standard Specification for Cellular Glass Thermal Insulation
3. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
4. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
5. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
6. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
7. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
8. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
9. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
10. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

### 1.3 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

B. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

### 1.4 QUALITY ASSURANCE

A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

B. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
1. CertainTeed.
2. Knauf.
3. Johns Manville.
4. Owens-Corning.
5. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Manufacturers for Closed Cell Elastomeric Insulation Products:
1. Aeroflex. Aerocell.
2. Armacell, LLC. Armaflex.
3. Nomaco. K-flex.
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

2.2 PIPE INSULATION

A. P-1: ASTM C547, rigid, molded glass fiber pipe insulation.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.
5. Where multiple layers of insulation are required, only the exterior layer shall be required to have the jacket applied. Multiple layers seams shall be staggered.

B. P-2: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:
   1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:
   1. Product Description: One piece molded type fitting covers and sheet material, off-white color.
   2. Thickness: 10 mil.
   3. Connections: Brush on welding adhesive.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self adhesive closure. Thickness to match pipe insulation.

F. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

G. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. E-1: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

2.6 EQUIPMENT INSULATION JACKETS

A. Vapor Retarder Jacket:
   1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Equipment Jacket:
   1. Product Description: ASTM D1785, sheet material, off-white color.
   2. Minimum Service Temperature: -40 degrees F.
   3. Maximum Service Temperature: 150 degrees F.
   4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
   5. Thickness: 10 mil.
   6. Connections: Brush on welding adhesive.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Adhesives: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify piping and equipment have been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

C. Hot Piping Systems less than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

D. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.

b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

E. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

F. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

G. Prepare pipe insulation for finish painting.

## 3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

F. Prepare equipment insulation for finish painting.

## 3.4 SCHEDULES

A. Refer to the Pipe and Pipe Insulation Schedules on the drawings.

## 3.5 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

End of section

# SECTION 22 11 00 - PLUMBING SPECIALTIES & CLEANING

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Pressure gages.
2. Pressure gage taps.
3. Thermometers.
4. Water pressure reducing valves.
5. Relief valves.
6. Backflow preventers.
7. Thermostatic mixing valves.
8. In-line circulator pumps.
9. Cleaning

### 1.2 REFERENCES

A. American National Standards Institute:
1. ANSI Z21.22 - Relief Valves for Hot Water Supply Systems.

B. American Society of Mechanical Engineers:
1. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
2. ASME B31.9 - Building Services Piping.
3. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.

C. American Society of Sanitary Engineering:
1. ASSE 1010 - Performance Requirements for Water Hammer Arresters.
2. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
3. ASSE 1012 - Performance Requirements for Backflow Preventer with Intermediate Atmospheric Vent.
4. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
5. ASSE 5013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers (RP) and Reduced Pressure Fire Protection Principle Backflow Preventers (RFP).

D. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
3. ASTM B32 - Standard Specification for Solder Metal.
4. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
5. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

6. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
7. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
8. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
9. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
10. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
11. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
12. ASTM D 3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns.
13. ASTM E1 - Standard Specification for ASTM Thermometers.
14. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.
15. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
16. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
17. ASTM F 891 - Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core.
18. ASTM F1281 - Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe.

E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:
1. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
3. AWWA C651 - Disinfecting Water Mains.
4. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
5. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
6. AWWA C702 - Cold-Water Meters - Compound Type.
7. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
9. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

G. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 67 - Butterfly Valves.
3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
4. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
5. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
6. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
7. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
8. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

9. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

H. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

I. Plumbing and Drainage Institute:
1. PDI WH201 - Water Hammer Arrester Standard.

J. Underwriters Laboratories Inc.:
1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.3 SUBMITTALS

A. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturer's catalog information.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
4. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

B. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and equipment.

B. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

1.5 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept valves and equipment on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 PRESSURE GAGES

A. Gage: ASME B40.1 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
   1. Case: Stainless steel.
   2. Bourdon Tube: Type 316 stainless steel.
   3. Dial Size: 4 inch diameter.
   4. Mid-Scale Accuracy: One percent.
   5. Scale: Psi.

2.2 PRESSURE GAGE TAPS

A. Needle Valve: Brass 1/4 inch NPT for minimum 300 psi.

B. Ball Valve: Brass 1/4 inch NPT for 250 psi.

C. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.

2.3 STEM TYPE THERMOMETERS

A. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
   1. Size: 9 inch scale.
   2. Window: Clear glass.
   3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
   4. Accuracy: 2 percent.
   5. Calibration: Degrees F

2.4 WATER PRESSURE REDUCING VALVES

A. 2 inches and Smaller: MSS SP 80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded ends.

B. 2 inches and Larger: MSS SP 85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.5 RELIEF VALVES

A. Pressure Relief:

1. ANSI Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

B. Temperature and Pressure Relief:
1. ANSI Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME certified and labeled.

## 2.6 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventers:
1. Comply with ASSE 1013.
2. Bronze body, with bronze internal parts and stainless steel springs.
3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

B. Double Check Valve Assemblies: Comply with ASSE ASSE 1015 or AWWA C510; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

## 2.7 THERMOSTATIC MIXING VALVES

A. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment. Conform to ASSE 1070 to temper water to maximum 110 degrees F.

B. Accessories:
1. Check valve on inlets.
2. Volume control shut-off valve on outlet.
3. Stem thermometer on outlet.
4. Strainer stop checks on inlets.

C. Cabinet: 16 gage stainless steel, for recessed mounting with keyed lock.

# PART 3 EXECUTION

## 3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

## 3.2 INSTALLATION - THERMOMETERS AND GAGES

A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.

B. Install gage taps in piping.

C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.

E. Provide instruments with scale ranges selected according to service with largest appropriate scale.

F. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

G. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.3 FIELD QUALITY CONTROL

A. Test domestic water piping system in accordance with applicable code.

3.4 CLEANING

A. Prior to starting work, verify system is complete, flushed and clean.

B. Verify pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder and tablet or gas form, throughout system to obtain residual from 50 to 80 mg/L.

D. Bleed water from outlets to obtain distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. When final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual concentration is equal to incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

I. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

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# SECTION 22 11 23 - FACILITY NATURAL-GAS PIPING

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Natural gas piping buried within 5 feet of building.
2. Natural gas piping above grade.
3. Unions and flanges.
4. Valves.
5. Pipe hangers and supports.
6. Strainers.
7. Natural gas pressure regulators.
8. Natural gas pressure relief valves.
9. Underground pipe markers.

### 1.2 REFERENCES

A. American National Standards Institute:
1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

B. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
4. ASME B31.9 - Building Services Piping.

C. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.

E. American Water Works Association:
   1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 67 - Butterfly Valves.
   3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
   5. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
   6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

G. National Fire Protection Association:
   1. NFPA 54 - National Fuel Gas Code.

H. Underwriters Laboratories Inc.:
   1. UL 842 - Valves for Flammable Fluids.

## 1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.

C. Provide pipe hangers and supports in accordance with ASME B31.9.

D. Use plug valves for shut-off and to isolate equipment, part of systems, or vertical risers.

## 1.4 SUBMITTALS

A. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
   2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
   3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
   4. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
      a. Strainers.
      b. Natural gas pressure regulators.
      c. Natural gas pressure relief valves.

B. Test Reports: Indicate results of piping system pressure test.

C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves, piping system, and system components.

B. Operation and Maintenance Data: Submit for valves and gas pressure regulators, installation instructions, and spare parts lists.

1.6 QUALITY ASSURANCE

A. Perform natural gas Work in accordance with NFPA 54.

B. Perform work in accordance with International Fuel Gas Code.

C. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Furnish one year manufacturer warranty for valves excluding packing.

PART 2 PRODUCTS

2.1 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   1. Fittings: ASTM A234/A234M forged steel welding type.
   2. Joints: ASME B31.9, welded.
   3. Jacket: AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.2 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
   2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

B. Corrugated Stainless Steel Tubing: ANSI LC 1.

2.3 REGULATOR VENT PIPING, ABOVE GRADE

A. Indoors: Same as natural gas piping, above grade.

B. Outdoors: PVC pipe, tubing, and fittings, UL 651.

2.4 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
   1. Ferrous Piping: Class 150, malleable iron, threaded.
   2. Copper Piping: Class 150, bronze unions with soldered brazed joints.
   3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:
   1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
   2. Copper Piping: Class 150, slip-on bronze flanges.
   3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.5 PLUG VALVES

A. Manufacturers:
   1. DeZURIK, Unit of SPX Corp.
   2. Flow Control Equipment, Inc.
   3. Homestead Valve
   4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. 2 inches and Smaller: MSS SP 78, Class 150 construction, full port, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.

C. 2-1/2 inches and Larger: MSS SP 78, Class 150, semi-steel construction, full port, pressure lubricated, teflon packing, flanged ends. Furnish wrench-operated.

2.6 STRAINERS

A. Manufacturers:
   1. Mueller Steam Specialty Model
   2. O.C. Keckley Company Model
   3. Spirax Sarco, Inc. Model
   4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.7 NATURAL GAS PRESSURE REGULATORS

A. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
   1. Comply with ANSI Z21.80.
   2. Temperatures: minus 20 degrees F to 150 degrees F.
   3. Body: Cast iron or Steel.
   4. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
   5. Disk, diaphragm, and O-ring: Nitrile
   6. Maximum inlet pressure: 150 psig.
   7. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

2.8 NATURAL GAS PRESSURE RELIEF VALVES

A. Product Description: Spring loaded type relief valve.
   1. Body: Aluminum.
   2. Diaphragm: Nitrile
   3. Orifice: Aluminum, Brass or Stainless steel.
   4. Maximum operating temperature: 150 degrees F.
   5. Inlet Connections: Threaded.
   6. Outlet or Vent Connection: Same size as inlet connection.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

A. Install natural gas piping in accordance with NFPA 54.

B. Verify connection size, location, and invert are as indicated on Drawings.

C. Establish elevations of buried piping with not less than three feet of cover.

D. Establish minimum separation of from other services piping in accordance with code.

E. Install medium pressure gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.

F. Install medium pressure gas pressure regulator with tee fitting not less than 10 pipe diameters down stream of regulator. Cap or plug one opening of tee fitting.

G. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors .

H. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 14 inch wg. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

## 3.4 FIELD QUALITY CONTROL

A. Where gas appliance will be damaged by test pressure, disconnect appliance and cap piping during pressure test. Reconnect appliance after pressure test and leak test connection.

B. Where gas appliance is designed for operating pressures equal to or greater than piping test pressure, provide gas valve to isolate appliance or equipment from gas test pressure.

C. Pressure test natural gas piping in accordance with NFPA 54.

D. When pressure tests do not meet specified requirements, remove defective work, replace and retest.

E. Immediately after gas is applied to a new system, or a system has been restored after gas service interruption, check pipe for leakage.
   1. Where leakage is detected, shut off gas supply until necessary repairs are complete.

F. Do not place appliances in service until leak testing and repairs are complete.

## 3.5 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

# SECTION 22 40 00 - PLUMBING FIXTURES

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Service sinks.
6. Electric water coolers.
7. Showers.

### 1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ANSI Z124.2 - Plastic Shower Units.
3. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

B. Air-Conditioning and Refrigeration Institute:
1. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.

C. American Society of Mechanical Engineers:
1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
2. ASME A112.18.1 - Plumbing Fixture Fittings.
3. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
4. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
5. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
6. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
7. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.

### 1.3 SUBMITTALS

A. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

B. Manufacturer's Installation Instructions: Submit installation methods and procedures.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.5 QUALITY ASSURANCE

A. Provide products requiring electrical connections listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

B. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept fixtures on site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.7 WARRANTY

A. Furnish one year manufacturer warranty for plumbing fixtures.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Fixtures:
1. Kohler.
2. Toto.
3. American Standard.
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Flush Valves:
1. Sloan.
2. Zurn Industries.
3. Toto
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

C. Fixture Carriers:
1. Jay R. Smith.
2. Josam.
3. Mifab.
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

D. Electric Water Coolers:
1. Elkay.
2. Haws.
3. Oasis.
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

E. Sanitary Sewer Plumbing Fixutres:
1. Mifab.
2. Jay R. Smith.
3. Zurn Industries.
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

2.2 Refer to schedules on plans for specific equipment requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify electric power is available and of correct characteristics.

C. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall carriers and bolts.

E. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.

F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

G. For ADA accessible water closets, install flush valve with handle to wide side of stall.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.5 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Clean plumbing fixtures and equipment.

B. Construction Waste: In accordance with Section 01 74 19.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Do not permit use of fixtures before final acceptance.

**END OF SECTION**

# SECTION 23 00 00 - GENERAL MECHANICAL REQUIREMENTS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. This Section includes requirements that expand the requirements specified in Division 01 – General Requirements and applies to all Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC) Specification Sections. It is the intent of the contract documents to provide an installation complete in every respect. Work shall be executed in a workmanlike manner and shall include all labor, materials, and supervision essential to provide complete functioning systems as described in the contract documents. In the event that additional details or special construction is required for work indicated, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation at no expense to the Owner.

C. Conflict Resolution: Where conflicts may exist between the minimum requirements of various laws, codes, authorities, and/or within the Contract Documents, the higher quality, greater quantity, more restrictive and/or more expensive requirement shall be the basis of Contractor pricing and the Contractor shall notify the Engineer for the resolution of the issue prior to executing the work in question.

D. Should any errors, omissions, conflicts, or ambiguities exist in the drawings, the Contractor shall bring these to the attention of the Engineer immediately for adjustment in writing before signing the contract or proceeding with the work. Otherwise, he shall at his own expense, supply the proper materials and labor to make good any damage or defect caused by such unintentional error.

E. Contractor is responsible for checking all contract documents, field conditions and dimensions for accuracy, and confirming that the work is buildable as shown and meets all applicable codes before proceeding with construction. If there are any questions regarding these or other coordination issues, the Contractor is responsible for obtaining a clarification from the Engineer before proceeding with the work in question or related work.

F. Contractor shall direct all questions to the Owner's project coordinator. The Contractor shall verify all working conditions such as starting time, noise and vibration limitations, confined space, etc. Through the project coordinator and approval shall be received to start work.

G. Field Conditions: The Contractor is responsible for visiting the jobsite and verifying the scope of work required including all existing conditions, locations, dimensions, and quantities as shown and noted on the drawings and the extent and effect of existing systems. The Contractor shall be responsible for field verification of existing conditions. Perform field measurements prior to fabrication and/or purchase of any material and contact the project manager should existing conditions be different from the design drawings. Conflicts arising due to lack of coordination shall be the responsibility and at the expense of the Contractor.

H. The Engineer shall interpret the design intention. Deviations to the intended design or the scope of the work must be approved by the Engineer prior to commencing work. Failure to do so may result in the work to be removed at no cost to the Owner.

I. All work shall be performed in accordance with all applicable local codes, standards, and amendments and/or other authorities that may have jurisdiction pertaining to the work. In addition, all work shall conform to the standards and practices of the Owner.

1. Seismic requirements: Provide seismic provisions/restraints as required by the New Mexico Building Code.

    a. As defined in the Structural drawings, this building is defined as follows:

        1) Soil Class D

        2) Seismic Design Category C

        3) Importance Factor 1.25

    b. Calculations shall be by a Professional Engineer experienced in doing seismic calculations.

    c. Seismic restraints shall be in accordance with ASHRAE and SMACNA standards/guidelines.

2. Wind: Provide supports and restraints as required by the New Mexico Building Code for mechanical systems located on roofs.

J. Coordination:

1. The Contractor shall be responsible for ensuring full coordination with other trades and Contractors to accomplish the work as shown and noted in these contract documents. The Contractor shall compare the drawings of other trades and report any discrepancies to the Owner's representative.
2. The Contractor shall not fabricate or install items as shown on the drawings if there are discrepancies or conflicts between the existing conditions and the information shown on the drawings until such discrepancies have been resolved. Prior to fabrication or installation, the Contractor shall immediately call such discrepancies or conflicts to the attention of the project coordinator.
3. Ductwork, piping, conduit, cabling, etc. shown on drawings shall be coordinated with air distribution devices, special ceiling, floor, and structure construction, etc. Provide additional rises and drops to those indicated on the drawings as required to coordinate with architectural, structural or MEP elements shown on the contract documents. All utilities shall be routed in an orderly manner, grouped together wherever possible, and located so as to conserve building space. Ductwork, piping, conduit, cabling, etc. shown on each plan is run above the ceiling on the floor where it is shown unless otherwise noted.
4. Coordinate locations of new and existing roof penetrations to minimize number of openings. Roof penetrations shall be made within roof curbs. Electric and refrigerant and condensate lines to use same penetrations where possible.

K. As-Builts: The Contractor shall maintain his set of construction drawings on site at all times so that all changes between the drawings and the actual construction can be noted on the drawings. This includes all deviations from the original contract. The Contractor shall indicate all changes from the original plans made during the installation of his work in red ink on two blueline prints. At the end of construction, the Contractor shall sign and date the drawings certifying that they are an accurate reflection of the actual construction. As-built drawings are to be delivered to the Owner's project coordinator after project completion. Note that the final invoice for the contract will not be paid by the Owner until final as-built drawings are received.

L. All work noted "NIC" or "Not in Contract" is to be accomplished by another Contractor and is not to be part of the construction agreement.

1.2 DEFINITIONS

A. Furnish: To purchase and deliver products to the project site and prepare for installation.

B. Install: To assemble, erect, secure, connect, and place furnished product into operation.

C. Provide: To furnish and install.

D. Products: Includes materials, systems, parts, and equipment.

E. Concealed: Embedded in or installed behind walls, within partitions, above suspended ceilings, in trenches, in tunnels and crawl spaces.

F. Exposed: Not installed underground or "concealed" as defined above.

G. Specifications: These specifications plus the Codes and Standards referenced herein.

1.3 CONTRACTOR QUALIFICATIONS

A. General: The firms that perform the installation of the work under this Division of specifications shall be one that maintains an established, experienced organization with a permanent, manned office within a radius of 250 miles of the project location.

B. Mechanical Firm’s Proficiency: The firm's proficiency in the installation, start-up, adjustment and maintenance of air conditioning systems shall have been demonstrated by the successful performance of work on at least three systems as specified herein in the last three years. The firm shall have trained personnel, instruments, tools, and equipment to perform the installation and maintenance service specified. The firm shall have been in business performing services as specified herein for at least three years.

1.4 SAFETY:

A. Contractor shall comply with all applicable safety standards including, but not limited to OSHA standards and Owner’s requirements.

B. Contractor shall comply with State of New Mexico, local government, and WNMU health requirements regarding Covid-19.

C. All safety exposures or violations shall be rectified immediately by the Contractor. The Contractor shall be responsible for providing protection of persons and property, providing safe working conditions throughout the work progress, providing temporary coverings for openings through walls or floors, and providing temporary barriers, partitions and/or dust barriers where required to maintain OSHA and the Owner's safety standards and to prevent damage to property. All areas adjacent to the construction area or affected by the construction must be protected from damage, cleaned, and restored to the original condition at no additional expense to the Owner. The Contractor shall provide protective clothing and eyewear for all personnel who are required to handle hazardous chemical products or work in hazardous locations.

D. Submit material safety data sheets and manufacturer's current recommended method of installation for all materials used to perform the work indicated by these documents. All submittals shall be prepared according to current Owner specifications and shall be approved prior to starting any work. All chemicals or chemical compounds proposed for use on the property including, but not limited to paint thinners, solvents, adhesives, sealants, cleaning compounds, epoxies, etc. Must be approved by the Owner.

E. Dispose of debris, trash, and hazardous materials in accordance with all applicable codes.

F. The Contractor shall be responsible for training his/her employees and subcontractors as required by the Owner, and in the recognition and avoidance of unsafe conditions, and in the regulations and hazards which apply to the area in which the work will take place.

G. Work areas shall be kept continuously and at all times, free of debris and non-hazardous material to the satisfaction of the project coordinator. All existing piping and conduits shall have temporary protection during construction. The Contractor shall coordinate storage of materials, parking of vehicles, and restrictions of work with the project coordinator. After project completion, the site shall be cleaned up and restored to its condition or better prior to the start of the project to the satisfaction of the project coordinator.

1.5 QUALITY CONTROL

A. Comply with manufacturers' instructions, including each step in sequence of work installation.

B. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

D. Conform to reference standard by date of issue current on date of Contract Documents date for receiving bids, except where a specific date is established by code.

1.6 SUBMITTALS

A. Contractor shall provide product data submittals on all major equipment, components, and materials specified in these plans for Engineer's and Owner's review and acceptance prior to installation.

B. Quantity: Submit one electronic .pdf set of data for each submittal.

C. Each submittal shall include the project title, Architect, Engineer, Contractor's names, specification section number and title, submittal number for tracking and shall be limited to a single Division 23 Specification Section. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

D. Contractor Review: The Contractor shall check data carefully to insure compliance with these specifications prior to submitting. For product data describing two or more variants of the same model product, clearly mark the selected product and all included accessories and options. Stamp and sign each submittal section indicating review and approval and provide notes indicating any variances that exist.

E. Submittal data for Section 23 00 00 – General Mechanical Requirements:
   1. Coordination Drawings: Indicate the proposed locations of equipment, ductwork, piping, and materials by preparing floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. The sheet metal drawing shall be the Base Sheet. Other drawings produced shall be coordination drawing overlays, so interferences can be detected. Prepare coordination drawings to a scale of 1/4" = 1'-0" or larger clearly indicating the following:
      a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
      b. Clearances for installing and maintaining insulation.
      c. Clearances for installing and maintaining valves, dampers, and their actuators.
      d. Equipment connections and support details.
      e. Roof penetrations.
      f. Fire-rated wall and floor penetrations.
      g. Sizes and location of required roof mounted equipment supports/bases.
      h. Indicate locations where space is limited for installation and maintenance.
      i. Indicate location of existing utilities, ducts, piping and equipment that are to remain.
      j. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

F. Submittal data for other Division 23 Specification Sections: Provide data as required in each individual Division 23 Specification Sections. Submittal data types are as follow:
   1. Compliance Data: Published literature, certificates, and lists indicating the product's compliance with standards referenced in these specifications.
   2. Published Literature: Indicate dimensions, weights, capacities, ratings, horsepower, gages, and finishes of materials, and electrical characteristics and connection requirements.
   3. Performance Data: Performance data including fan curves, pump curves, and equipment output capacities complete with rating conditions as scheduled on contract drawings. As a minimum submitted data shall include all performance data scheduled or noted on contract drawings.
   4. Sound Power Level Data: Equipment sound power level at 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz octave band center frequencies plus db A weighted sound level. Data shall include distance from equipment to test equipment.
   5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
   6. Samples and Color Selection Charts.

7. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
8. Manufacturer's Instructions: Include installation instructions.

## 1.7 SUBSTITUTIONS

A. Basis of Design: Model numbers indicated in other Division 23 Specification Sections or shown on the drawings are the Basis of Design. The Contractor may request substitution of equal and approved equipment from manufacturers listed in this specification or set forth in an addendum provided said equipment meets all requirements of the plans and specifications, has like electrical characteristics (e.g., same voltage, phase, fusing/circuit breaker requirements, single or multiple points of connection as indicated on the electrical drawings), and will fit in the available spaces in the building as shown.

B. If the Contractor chooses to provide equipment which meets all requirements, but has different connection sizes and/or locations, different weight or footprint, or electrical characteristics, etc., he shall bear all costs associated with the installation of that substitution. All required modifications shall be coordinated with the Engineer, the General Contractor, and affected subcontractors of other trades.

C. Substitutions: Substitutions of specified items will be considered until 7 days prior to bid opening. Each request shall include a description of the proposed substitute, the name of material or equipment for which it is to be substituted, drawings, cuts, performance and test data for an evaluation and a statement from the equipment manufacturer's representative that the items to be substituted meet or exceed the specifications of the item substituted for.

D. A request for substitution constitutes a representation that the Contractor:
1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
2. Will provide the same warranty for the Substitution as for the specified Product.
3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension which may subsequently become apparent.
5. Will reimburse Owner and Engineer for review or redesign services associated with re-approval by authorities.

E. The Engineer will notify Contractor in writing of decision to accept or reject request.

## 1.8 SUSTAINABLE DESIGN SUBMITTALS

A. Comply with the requirements in specification section 01 81 13 Sustainable Design Requirements.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver Products to the project in manufacturer's original shipping packaging, properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Acceptance at Site: Comply with the following requirements:
   1. Inspect shipments and immediately report any damage to the carrier and to the Construction Manager so that job progress will not be delayed.
   2. All items received by the Contractor shall be left in their original containers, or as shipped with dust caps, packing materials, and weather proof covers until installed in final locations.

C. Storage and Protection: During construction maintain all delivered materials and equipment in an orderly manner and protect from damage by complying with the following minimum requirements:
   1. Products stored outside or in unheated spaces shall be covered with waterproof drop cloths or tarpaulins, and provided with blocking to raise the base of each item at least 6 inches above ground and water levels.
   2. Store electrical items that would be damaged by cold weather or condensation in a heated, enclosed space until placed into service.
   3. Products stored inside shall be protected from dirt, construction debris, welding and cutting spatters, paint dropping etc. either by original packaging or Contractor provided covers.
   4. All installed materials and equipment shall be in a like new condition. Damaged equipment or materials shall be repaired to like new conditions or replaced at no cost to the Owner.

1.10 SEQUENCING AND SCHEDULING

A. Carefully examine the site, civil, structural, architectural, plumbing, mechanical (HVAC), fire protection, and electrical drawings and specifications. Coordinate all work with other disciplines to avoid conflicts and delay of installation schedule.

B. The Contractor shall install his work so as not to interfere with the work of other disciplines or trades. If work is installed that does interfere, the work shall be corrected at no additional cost to the Owner. Occupation of a work space by any trade or discipline does not give the right of priority to the space.

C. Tests: Test requirements shall be as specified in other Division 23 Specification Sections. Provide the engineer 48 hours notification in advance of any test. Engineer, at his option, may witness test. Complete tests prior to insulating or otherwise covering work. Leaks shall be repaired, defective materials replaced, and system shall be retested. No water pressure test shall be conducted in freezing weather. Conduct test prior to connecting to equipment or isolate equipment from system.

1.11 UTILITY CONNECTIONS AND PERMITS

A. The Contractor shall be responsible for securing and paying for all permits, licenses, clearances, and certificates, as required by the Owner and the authorities having jurisdiction. Obtain these as required prior to the commencement of the work.

B. Prior to commencement of work, verify with the Owner’s representative and the utility companies, that all available information is known regarding underground utilities. Take caution in order to not disturb any existing underground utilities. Notify Owners representative immediately upon uncovering unknown utilities; wait for further direction.

1.12 COMPLETION OF WORK

A. Execute final cleaning prior to final inspection.

B. Final Cleaning: Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

C. Clean construction debris from roof.

D. Remove waste and surplus materials, rubbish, and construction facilities from the site.

E. Contractor to provide start-up and commissioning services for systems and equipment, as well as training services for the Owner's maintenance personnel in the use of these systems and equipment. Adjust operating products and equipment to ensure smooth and correct operation.

F. Upon completion of construction, Contractor shall demonstrate proper functionality of all fire smoke dampers and smoke detectors to Owner and Engineer.

G. At completion, the Contractor shall demonstrate that the entire system is in specified working condition. The following shall be available:
1. Owner's Representative.
2. Contractor representative.
3. Mechanic with hand tools, ladder and flashlight.
4. Test and Balance Report.
5. Complete specifications and drawings with all addenda and revisions.
6. Owner’s Operation and Maintenance Manual.

1.13 GUARANTEE AND WARRANTIES

A. All Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC) warranty periods begin at the date specified in the Contract. The Contractor shall make provisions so that manufacturer’s warranties begin on that date regardless of when equipment is delivered to the project site.

B. Warranties: Provide manufacturer's equipment warranties prior to final inspection. Length of warranty period shall be as specified in individual Division 23 Specification Sections.

C. Guarantee: All equipment and materials furnished and all work performed under this Division of specifications shall be guaranteed to be free of defective materials and workmanship for a period of one year from the date specified in paragraph A above. Upon notice from the Owner of failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts shall be promptly replaced with new parts by the Contractor at no additional cost to the Owner. All labor required to perform guarantee shall be included as part of the complete guarantee warranty.

1.14 MAINTENANCE AND SERVICE

A. Maintenance: The Contractor shall maintain all systems installed under this Section of specifications for one year from date of final certificate.

B. Inspections: Provide four maintenance inspections at 90-day intervals. Check, repair, clean, adjust, and lubricate equipment. Replace filter media when exhausted or clean permanent filters.

C. Parts: Provide repair parts during maintenance periods.

1.15 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, Product Data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Contract Close-Out Record Documents: Prepare construction record documents, in AutoCAD or Revit files provided by the Engineer, to include all addenda and change orders and indicating the following installed conditions:
1. Ductwork size and location; locations of dampers, control devices, filters, and air devices.
2. Equipment locations (exposed and concealed), identification, dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
4. Submit documents with claim for final Application for Payment.

1.16 MAINTENANCE DOCUMENTS AND INSTRUCTIONS

A. Maintenance Training: After placing systems in operation, provide members of Owner’s maintenance staff with 16 hours of operation and maintenance training for systems included in this Section of specifications.

B. BAS Training: Provide Building Automation System (BAS) training as specified in Section 23 09 23 – Digital Control Equipment.

C. Maintenance Manuals: Three bound and indexed Operating and Maintenance Manuals shall be prepared by the Contractor and be submitted to the Engineer for approval prior to delivery to operating personnel. Each manual shall contain the following information, data, and drawings:
1. List of contents. Insert under front cover.
2. Copy of approved submittals, equipment, and materials.
3. Installation, operating, and maintenance instructions for each item of equipment.
4. Wiring schematics for each item of equipment.

5. Manufacturer's list of renewal parts for each item of equipment with recommended stock items and quantities indicated.
6. Manufacturer's equipment warranties.
7. Copy of Test and Balance Reports including list of instruments and description of methods employed.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 PROTECTION OF EXISTING SITE

A. Protect the project site, inside and outside from damage.

B. Obtain prior permission from the Owner before using the exterior site for any purpose, including, but not limited to, the following:
   1. Laydown of equipment and materials.
   2. Parking of vehicles or driving on by vehicles, cranes, etc.

3.2 ASBESTOS

A. The Contractor shall ensure that all his personnel and that all of his subcontractors are made aware during demolition, or any similar work, or in the process of connecting to or working adjacent to existing equipment or materials, that at any time any workman encounters any suspect asbestos type material, all work in that area shall be stopped immediately and the suspect spaces kept cleared until a positive decision by a properly qualified person has been determined. In the event the suspect material proves to be asbestos, all affected areas shall be kept isolated until all such asbestos material has been removed and the spaces affected duly approved for normal use. It is to be noted that only authorized and approved personnel shall be allowed to participate in any manner whatsoever either in the search of or the removal of asbestos suspect material.

B. No asbestos containing materials shall be used in any of the new construction.

3.3 DEMOLITION

A. General: Provide demolition of existing mechanical work in remodeled areas of the existing building and as described on the drawings. Dispose of removed equipment and materials in a way to maximize recycling content. In addition to work indicated on drawings, demolition includes, but is not necessarily limited to, the following:
   1. Removal of all abandoned piping, ducts, supports, equipment, control wiring, etc.
   2. Capping and plugging of piping where demolition begins.
   3. Removal of all abandoned control devices and abandoned exposed pneumatic tubing and control wiring. Abandoned pneumatic tubing and control wiring throughout accessible ceiling spaces shall also be removed.

B. Salvage Equipment and Materials: Existing equipment and materials designated for salvage back to the Owner or reinstallation shall be tested for proper operation prior to removal from its installed location. After removal, salvage equipment found defective shall be removed

from the Owner's property at no extra cost to the Owner. Salvage equipment found in good working order shall be turned over to the Owner's agent. Defective equipment designated for reinstallation shall be repaired or replaced per bid alternate pricing for repair/replace of existing equipment. Equipment found in good working order, or repaired, and scheduled for reinstallation shall be cleaned, serviced, and stored at Contractor's expense until it is again installed in the building.

3.4 ROUGH-IN

A. Final Locations: Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Coordinate mechanical systems, equipment, and materials installation with other building components.

B. Prepare for Installation: Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

C. Deviation From Drawings: Drawings are schematic and show approximate location of equipment and materials, however, the Contractor shall obtain the Engineer's approval before deviating from the drawings. Written dimensions shall take precedence over scaled dimensions.

3.5 MECHANICAL INSTALLATIONS

A. General: Installation shall be as specified in individual Division 23 Specification Sections and in accordance with approved manufacturer's installation instructions. Conflict between manufacturer's printed instructions and these specifications shall be brought to the attention of the Engineer.

B. Equipment: All equipment installed on this project shall be new and unused unless noted otherwise. The Contractor shall remove all shipping labels, dirt, paint spots, grease, and stains from all equipment. Debris shall be removed as it accumulates. Upon completion of his work, the Contractor shall clean all equipment. No loose parts or scraps of equipment shall be left on the premises.

C. Installation: Install systems, materials, and equipment to conform to approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
   1. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
   2. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
   3. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

4. Install systems, materials, and equipment level and plumb parallel and perpendicular to other building systems and components, following the building lines, where installed exposed in finished spaces.
5. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
6. Provide access panels or doors where units are concealed behind finished surfaces.
7. Install isolation valves at all piping branch taps (water, air, steam, etc.).

D. Cleaning: Comply with the following cleaning requirements:
1. Upon completion of installation, piping, ducts, and equipment shall be thoroughly cleaned of dirt, grease, rust and oil, primed where necessary, and left ready for painting. Vacuum-clean the inside and outside of plenums and equipment cabinets.
2. Clean gages, thermometers, traps, strainers, fittings, and lavatory aerators.

E. Painting and Finishing: Comply with the following finishing requirements:
1. Contractor shall clean, spot prime with zinc chromate and entirely repaint, with original color any factory finished equipment which has rusted or been damaged.
2. Insulation coverings shall be cleaned, sized if necessary, and left ready for service identification.
3. Ferrous metal shall be cleaned and primed, ready for painting.

F. Lubrication and Packing: Comply with the following requirements:
1. Lubricate equipment with correct grade, type, and quantity of lubrication before placing equipment into service. Damages caused by not providing proper lubrication shall be repaired at Contractor's expense.
2. Each shaft or valve stem containing a packing gland shall be checked for condition and examined for proper grade, amount, and type of packing by backing packing gland off.
3. Maintain all lubrication and packing seals during construction, and assure that all are operating properly at the time of final acceptance. Replace worn gaskets and packing.
4. When filling systems initially for hydrostatic pressure tests, adjust valve packing glands to finger tight, and allow packing to absorb water for five minutes prior to tightening packing nuts.
5. All rotating pieces of equipment shall be properly lubricated prior to start-up. Damage to shafts, bearings, seals, etc., caused by lack of proper lubrication or over lubrication shall be repaired by the Contractor at no cost to the Owner.

## 3.6 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 – General Requirements. In addition to the requirements specified in Division 01 Specification Sections, the following requirements apply:
1. In new construction areas, use sleeves and inserts to avoid cutting concrete, masonry, and other finished work.
2. Any cutting through structural members or floors shall first be coordinated with the structural Engineer. No cutting, boring, or excavating which will weaken the structure shall be undertaken.
3. Cut holes through concrete, brick, tile, etc., when necessary, by rotary core drilling.
4. During cutting and patching operations, protect adjacent installations.

5. Perform at no expense to the Owner, cutting, fitting, and patching of mechanical equipment and materials required to:
   a. Uncover Work to provide for installation of ill-timed Work.
   b. Remove and replace defective Work.
   c. Remove and replace Work not conforming to requirements of the Contract Documents.
   d. Remove samples of installed Work as specified for testing.
   e. Install equipment and materials in existing structures.
   f. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer's observation of concealed Work.
6. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
7. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
8. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched. Repaired or patched surface finishes and components will match existing finishes. Use new materials.
9. All new wall and floor penetrations shall be made at 90 degree angles, unless shown otherwise, and shall be sealed fireproof with an approved sealant. All penetrations through fire-rated construction shall be sealed with UL 1479 listed through-penetration firestop systems.
10. There shall be no drilling into the floor above or below, without first contacting the Owner's designated representative.
11. All roof penetrations shall be provided by the appropriate trade, and the work shall be the responsibility of the General Contractor. Coordinate with the General Contractor to make sure that this is included in the General Contractor's scope of work.
12. Comply with Owner's roofing Contractor's warranty and/or roofing insurance requirements.

## 3.7 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

# SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes single- and three-phase motors for application on equipment provided under other sections.

### 1.2 REFERENCES

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

C. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

### 1.3 SUBMITTALS

A. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

B. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

B. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

C. For extended outdoor storage, remove motors from equipment and store separately.

## PART 2 PRODUCTS

### 2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

A. Motors 3/4 hp and Larger: Three-phase motor as specified below.

B. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
1. Voltage: 208 or 460 volts, three phase, 60 Hz, as indicated on Drawings.
2. Service Factor: 1.15.
3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
5. Insulation System: NEMA Class F.
6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
9. On inverter duty rated motors for use with variable frequency drives provide AEGIS shaft grounding rings.
10. Sound Power Levels: Conform to NEMA MG 1.

D. Single Phase Motors:
1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Voltage: 115 or 208 volts, single phase, 60 Hz.

E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

**PART 3 EXECUTION**

3.1 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.15.

3.3 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

# SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Hanger rods.
2. Inserts.
3. Flashing.
4. Equipment curbs.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Equipment bases and supports.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:
1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
2. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:
   1. UL 263 - Fire Tests of Building Construction and Materials.
   2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
   3. UL 1479 - Fire Tests of Through-Penetration Firestops.
   4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
   5. UL - Fire Resistance Directory.

G. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 SUBMITTALS

A. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

**PART 2 PRODUCTS**

2.1 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.2 INSERTS

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

2.3 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:
   1. Waterproofing: 5 lb./sq. ft sheet lead.
   2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.4 EQUIPMENT CURBS

A. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, variable step to match root insulation, 1-1/2 inch thick insulation, factory installed wood nailer.

B. See drawings, details, and schedules for additional requirements for equipment curbs.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

E. Sealant: Acrylic

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation
3. Substitutions: Per 23 00 00 – General Mechanical Requirements.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

A. Manufacturers:
1. Allied Tube & Conduit Corp.
2. B-Line Systems
3. Midland Ross Corporation, Electrical Products Division
4. Unistrut Corp.
5. Substitutions: Per 23 00 00 – General Mechanical Requirements.

B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

**PART 3 EXECUTION**

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME 31.9.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inch minimum vertical adjustment.

F. Support vertical piping at every floor.

G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide copper plated hangers and supports for copper piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

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

L. Provide clearance in hangers and from structure and other equipment for installation of insulation.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

B. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Provide curbs for roof installations 12 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach counterflashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.

C. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 2 inch above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install stainless steel escutcheons at finished surfaces in clean room spaces; chrome plated steel escutcheons may be used in all other finished spaces.

3.7 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.8 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

# SECTION 23 05 48 - VIBRATION ISOLATION

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
   1. Vibration isolators.

### 1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:
   1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

B. American National Standards Institute:
   1. ANSI S1.4 - Sound Level Meters.
   2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
   3. ANSI S1.13 - Methods for the Measurement of Sound Pressure Levels in Air.
   4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

C. Air-Conditioning and Refrigeration Institute:
   1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.

D. American Society of Heating, Refrigerating and:
   1. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
   2. ASHRAE Handbook - HVAC Applications.

E. ASTM International:
   1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
   3. ASTM E596 - Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures.

F. Sheet Metal and Air Conditioning Contractors':
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

### 1.3 SUBMITTALS

A. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

B. Design Data: Submit calculations indicating maximum room sound levels are not exceeded.

C. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.

1.4 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.5 WARRANTY

A. Provide one year manufacturer warranty.

**PART 2 PRODUCTS**

2.1 VIBRATION ISOLATORS

A. Open Spring Isolators (Type I-1):
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

B. Closed Spring Isolators (Type I-2):
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
   3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.

C. Spring Hanger (Type I-3):
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
   4. Misalignment: Capable of 20 degree hanger rod misalignment.

D. Rubber Mount or Hanger (Type I-4):
   1. Elastomer may be Neoprene or high synthetic rubber with anti-ozone and anti-oxidant additives.
   2. Mountings shall be designed for approximately 1/2" deflection and loaded so that deflection does not exceed 15% of the free height of the mounting.

E. Neoprene Pad Isolators (Type I-5):
   1. Rubber or neoprene-waffle pads.
      a. 30 durometer.
      b. Minimum 1/2 inch thick.
      c. Maximum loading 40 psi.
      d. Height of ribs: not to exceed 0.7 times width.
   2. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

**PART 3 EXECUTION**

3.1 EXAMINATION

A. Verify equipment, ductwork and piping is installed before work in this section is started.

3.2 INSTALLATION

A. Install isolation for motor driven equipment.

B. Adjust equipment level.

C. Install spring hangers without binding.

D. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

E. Block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

F. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector.

3.3 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections.

3.4 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

3.5 ISOLATOR APPLICATION

A. Equipment Isolation Schedule:

| Isolated Equipment | Isolator (Type/Deflection) | Base (Type) |
|---|---|---|
| Centrifugal Fans<br>Class I and II – Up to 54-¼ inch Diameter Up to 15 HP | I-1 / 2” | B-1 (If required) |
| Class I and II – 60-inch Diameter and Over, 15 HP and Over | I-1 / 4.5” | B-1 (If required) |
| Piping to Isolated Equipment | I-3 / Varies | N/A |
| | | |
| | | |
| | | |

**END OF SECTION**

# SECTION 23 05 53 - IDENTIFICATION FOR HVAC EQUIPMENT

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME A13.1 - Scheme for the Identification of Piping Systems.

B. National Fire Protection Association:
1. NFPA 99 - Standard for Health Care Facilities.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog literature for each product required.

B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

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

### 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of concealed dampers and air devices.

### 1.5 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

### 1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

**PART 2 PRODUCTS**

2.1 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

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

B. Metal Tags:
   1. Aluminum or Stainless Steel with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

C. Information Tags:
   1. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

D. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
   2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
   3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
   4. Ductwork and Equipment: 3 inches high letters.

B. Stencil Paint: Semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
   1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

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

2.5 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color-coded head.

B. Color code as follows:
   1. HVAC equipment: Yellow.

2. Fire dampers/smoke dampers: Red.

2.6 LABELS

A. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

**PART 3 EXECUTION**

3.1 PREPARATION

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

B. Prepare surfaces for stencil painting.

3.2 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

D. Install tags using corrosion resistant chain. Number tags consecutively by location.

E. Identify air handling equipment with plastic nameplates. Identify other small devices with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Tag automatic controls, instruments, and relays. Key to control schematic.

H. For exposed natural gas lines other than steel pipe, attach yellow pipe labels with "GAS" in black lettering, at maximum 10 foot spacing.

I. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

J. Provide ceiling tacks to locate dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.3 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

# SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Testing adjusting, and balancing of air systems.
2. Testing adjusting, and balancing of hydronic systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.

### 1.2 REFERENCES

A. Associated Air Balance Council:
1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:
1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

### 1.3 SUBMITTALS

A. Prior to commencing Work, submit proof of latest calibration date of each instrument.

B. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms, forms prepared following ASHRAE 111, or NEBB Report forms.

C. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

D. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty or Copy of NEBB Certificate of Conformance Certification.

E. Submit draft copies of report for review prior to final acceptance of Project.

F. Furnish reports in letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of balancing valves and rough setting.

B. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.6 QUALIFICATIONS

A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum five years documented experience certified by AABC or NEBB.

1.7 SEQUENCING

A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify systems are complete and operable before commencing work. Verify the following:
1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.

3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus or minus percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

A. Verify recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

D. Report defects and deficiencies noted during performance of services, preventing system balance.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.5 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.

L. Measure critical space differential static pressure and adjust outside air and exhaust air systems to obtain required relationship between each space as indicated on the pressure cascade drawings.

M. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

## 3.6 WATER SYSTEM PROCEDURE

A. Adjust water systems, after air balancing, to obtain design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.

C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

## 3.7 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
   1. Plumbing Pumps.
   2. HVAC Pumps.
   3. Water Tube Boilers.

4. Air Coils.
5. Humidifier Systems.
6. Terminal Heat Transfer Units.
7. Rooftop Air Handling Units.
8. Energy Recovery Systems
9. Fan Coil Units
10. Air Valves
11. Fans.
12. Air Filters.
13. Air Terminal Units.
14. Air Inlets and Outlets.
15. Campus Chilled Water Bypass Valve
16. Chilled Water and Heating Hot Water Control Valves

B. Report Forms
   1. Title Page:
      a. Name of Testing, Adjusting, and Balancing Agency
      b. Address of Testing, Adjusting, and Balancing Agency
      c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
      d. Project name
      e. Project location
      f. Project Architect
      g. Project Engineer
      h. Project Contractor
      i. Project altitude
      j. Report date
   2. Summary Comments:
      a. Design versus final performance
      b. Notable characteristics of system
      c. Description of systems operation sequence
      d. Summary of outdoor and exhaust flows to indicate building pressurization
      e. Nomenclature used throughout report
      f. Test conditions
   3. Instrument List:
      a. Instrument
      b. Manufacturer
      c. Model number
      d. Serial number
      e. Range
      f. Calibration date
   4. Electric Motors:
      a. Manufacturer
      b. Model/Frame
      c. HP/BHP and kW
      d. Phase, voltage, amperage; nameplate, actual, no load
      e. RPM
      f. Service factor
      g. Starter size, rating, heater elements
      h. Sheave Make/Size/Bore
   5. V-Belt Drive:
      a. Identification/location

b. Required driven RPM
c. Driven sheave, diameter and RPM
d. Belt, size and quantity
e. Motor sheave diameter and RPM
f. Center to center distance, maximum, minimum, and actual

6. Pump Data:
   a. Identification/number
   b. Manufacturer
   c. Size/model
   d. Impeller
   e. Service
   f. Design flow rate, pressure drop, BHP and kW
   g. Actual flow rate, pressure drop, BHP and kW
   h. Discharge pressure
   i. Suction pressure
   j. Total operating head pressure
   k. Shut off, discharge and suction pressures
   l. Shut off, total head pressure
7. Combustion Test:
   a. Manufacturer
   b. Model number
   c. Serial number
   d. Firing rate
   e. Overfire draft
   f. Gas meter timing dial size
   g. Gas meter time per revolution
   h. Gas pressure at meter outlet
   i. Gas flow rate
   j. Heat input
   k. Burner manifold gas pressure
   l. Percent carbon monoxide (CO)
   m. Percent carbon dioxide (CO2)
   n. Percent oxygen (O2)
   o. Percent excess air
   p. Flue gas temperature at outlet
   q. Ambient temperature
   r. Net stack temperature
   s. Percent stack loss
   t. Percent combustion efficiency
   u. Heat output
8. Cooling Coil and Energy Recovery Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual
   f. Entering air DB temperature, design and actual
   g. Entering air WB temperature, design and actual
   h. Leaving air DB temperature, design and actual
   i. Leaving air WB temperature, design and actual
   j. Water flow, design and actual

k. Water pressure drop, design and actual
l. Entering water temperature, design and actual
m. Leaving water temperature, design and actual
n. Saturated suction temperature, design and actual
o. Air pressure drop, design and actual

9. Heating Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual
   f. Water flow, design and actual
   g. Water pressure drop, design and actual
   h. Entering water temperature, design and actual
   i. Leaving water temperature, design and actual
   j. Entering air temperature, design and actual
   k. Leaving air temperature, design and actual
   l. Air pressure drop, design and actual
10. Fan Coil Data:
   a. Manufacturer
   b. Identification/number
   c. Location
   d. Model number
   e. Size
   f. Air flow, design and actual
   g. Water flow, design and actual
   h. Water pressure drop, design and actual
   i. Entering water temperature, design and actual
   j. Leaving water temperature, design and actual
   k. Entering air temperature, design and actual
   l. Leaving air temperature, design and actual
11. Air Moving Equipment:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Arrangement/Class/Discharge
   f. Air flow, specified and actual
   g. Return air flow, specified and actual
   h. Outside air flow, specified and actual
   i. Total static pressure (total external), specified and actual
   j. Inlet pressure
   k. Discharge pressure
   l. Sheave Make/Size/Bore
   m. Number of Belts/Make/Size
   n. Fan RPM
12. Return Air/Outside Air Data:
   a. Identification/location
   b. Design air flow
   c. Actual air flow
   d. Design return air flow

e. Actual return air flow
f. Design outside air flow
g. Actual outside air flow
h. Return air temperature
i. Outside air temperature
j. Required mixed air temperature
k. Actual mixed air temperature
l. Design outside/return air ratio
m. Actual outside/return air ratio

13. Exhaust Fan Data:
    a. Location
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Air flow, specified and actual
    f. Total static pressure (total external), specified and actual
    g. Inlet pressure
    h. Discharge pressure
    i. Sheave Make/Size/Bore
    j. Number of Belts/Make/Size
    k. Fan RPM
14. Duct Traverse:
    a. System zone/branch
    b. Duct size
    c. Area
    d. Design velocity
    e. Design air flow
    f. Test velocity
    g. Test air flow
    h. Duct static pressure
    i. Air temperature
    j. Air correction factor
15. Duct Leak Test:
    a. Description of ductwork under test
    b. Duct design operating pressure
    c. Duct design test static pressure
    d. Duct capacity, air flow
    e. Maximum allowable leakage duct capacity times leak factor
    f. Test apparatus
        1) Blower
        2) Orifice, tube size
        3) Orifice size
        4) Calibrated
    g. Test static pressure
    h. Test orifice differential pressure
    i. Leakage
16. Air Monitoring Station Data:
    a. Identification/location
    b. System
    c. Size
    d. Area

e. Design velocity
f. Design air flow
g. Test velocity
h. Test air flow

17. Flow Measuring Station:
    a. Identification/number
    b. Location
    c. Size
    d. Manufacturer
    e. Model number
    f. Serial number
    g. Design Flow rate
    h. Design pressure drop
    i. Actual/final pressure drop
    j. Actual/final flow rate
    k. Station calibrated setting
18. Terminal Unit Data:
    a. Manufacturer
    b. Type, constant, variable, single, dual duct
    c. Identification/number
    d. Location
    e. Model number
    f. Size
    g. Minimum static pressure
    h. Minimum design air flow
    i. Maximum design air flow
    j. Maximum actual air flow
    k. Inlet static pressure
19. Air Distribution Test Sheet:
    a. Air terminal number
    b. Room number/location
    c. Terminal type
    d. Terminal size
    e. Area factor
    f. Design velocity
    g. Design air flow
    h. Test (final) velocity
    i. Test (final) air flow
    j. Percent of design air flow
20. Sound Level Report:
    a. Location
    b. Octave bands - equipment off
    c. Octave bands - equipment on
    d. RC level - equipment on
21. Vibration Test:
    a. Location of points:
        1) Fan bearing, drive end
        2) Fan bearing, opposite end
        3) Motor bearing, center (when applicable)
        4) Motor bearing, drive end
        5) Motor bearing, opposite end

6) Casing (bottom or top)
7) Casing (side)
8) Duct after flexible connection (discharge)
9) Duct after flexible connection (suction)

b. Test readings:
1) Horizontal, velocity and displacement
2) Vertical, velocity and displacement
3) Axial, velocity and displacement

c. Normally acceptable readings, velocity and acceleration

d. Unusual conditions at time of test

e. Vibration source (when non-complying)

END OF SECTION

# SECTION 23 07 00 - HVAC INSULATION

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. HVAC piping insulation, jackets and accessories.
2. HVAC equipment insulation, jackets and accessories.
3. HVAC ductwork insulation, jackets, and accessories.

### 1.2 REFERENCES

A. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
14. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
15. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
16. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
17. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
18. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
19. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.

20. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
21. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
22. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
23. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

B. Sheet Metal and Air Conditioning Contractors':
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

C. Underwriters Laboratories Inc.:
   1. UL 1978 - Standard for Safety for Grease Ducts.

1.3 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

1.4 QUALITY ASSURANCE

A. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

B. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

C. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

B. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 WARRANTY

A. Furnish two-year manufacturer warranty for man-made fiber.

**PART 2 PRODUCTS**

2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
1. CertainTeed.
2. Knauf.
3. Johns Manville.
4. Owens-Corning.
5. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Manufacturers for Cellular Glass Insulation Products:
1. Pittsburgh Corning Foamglas.
2. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

C. Manufacturers for Closed Cell Elastomeric Insulation Products:
1. Aeroflex. Aerocell.
2. Armacell, LLC. Armaflex.
3. Nomaco. K-flex.
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
    a. Include vapor barrier jacket only on piping carrying fluids below ambient temperature.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.
5. Insulation on stainless steel piping must be chloride free insulation meeting ASTM C795.

B. TYPE P-2: ASTM C552, Type II Closed cellular glass insulation in preformed pieces.
1. Thermal Conductivity: 0.29 at 75 degrees F.
2. Operating Temperature Range: -450 to 900 degrees F.
3. Vapor Barrier Jacket: 30 mil thick, self-sealing, non-metallic modified bituminous vapor retarder membrane.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

C. TYPE P-3: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.3 PIPE INSULATION JACKETS

A. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 15 mil.
3. Connections: Sealed with FDA grade silicone.

B. Aluminum Pipe Jacket:
   1. ASTM B209.
   2. Thickness: 0.016 inch thick sheet.
   3. Finish: Smooth.
   4. Joining: Longitudinal slip joints and 2 inch laps.
   5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 1/2 inch wide; 0.015 inch thick aluminum.

## 2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Adhesives: Compatible with insulation.

G. Removable Insulation Covers:
   1. Insulation, thread, and jacket material shall be selected for intended service.
   2. Double sewn lock stitch with a minimum 4 to 6 stitches per inch. Jackets shall be sewn with two parallel rows of stitching using thread specific for the application. The thread must be able to withstand the skin temperatures without degradation. Jackets shall be fastened using hook and loop (Velcro) straps and 1” Slide Buckles. Hog rings, staples and wire are not are not acceptable methods of closure.
   3. Provide a stainless steel or brass grommet at the low point of each jacket, in wet areas for moisture drain (on horizontal jackets as required).
   4. Provide a permanently attached Aluminum or stainless steel nameplate on each jacket to identify its location, size and tag number.
   5. Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.
   6. Steam Trap and Steam Trap Station Jackets must be constructed in a box shape for removal and replacement inspection ease.
   7. Insulation thickness: As required for Touch Temperature less than 120 degrees F.
   8. ThermaXX or approved equal. Company specializing in manufacturing the products with minimum two years documented experience and made in USA.

## 2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: 0 to 650 degrees F.
   3. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE E-2: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

2.6 EQUIPMENT INSULATION JACKETS

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

B. Vapor Retarder Jacket:
   1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

C. Field Applied Glass Fiber Fabric Jacket System:
   1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
   2. Glass Fiber Fabric:
      a. Cloth: Untreated; 9 oz/sq yd weight.
      b. Blanket: 1.0 lb/cu ft density.
      c. Weave: 5 x 5.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Adhesives: Compatible with insulation.

2.8 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Maximum Operating Temperature: 250 degrees F.
   3. Density: 0.75 pound per cubic foot.

B. TYPE D-2: ASTM C1071, Type II, rigid, glass fiber duct liner with coated air side.
   1. Thermal Conductivity: 0.23 at 75 degrees F.
   2. Density: 3.0 pound per cubic foot.
   3. Maximum Operating Temperature: 250 degrees F.
   4. Maximum Air Velocity: 4,000 feet per minute.

2.9 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.

I. Membrane Adhesives: As recommended by membrane manufacturer.

## PART 3 EXECUTION

3.1 EXAMINATION

A. Verify piping, equipment and ductwork has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide appropriate firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Hot Piping Systems less than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

F. Hot Piping Systems greater than 140 degrees F:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

G. Inserts and Shields:
1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
   a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
   b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
3. Piping Supported by Roller Type Pipe Hangers: Install [galvanized] steel shield between roller and inserts.

H. Insulation Terminating Points:
1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

I. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer’s recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

J. Cellular Glass Insulation:
1. Insulation shall be taped or banded with all joints tightly butted and sealed with joint sealant. Poorly fitting or broken insulation shall be replaced or re-cut to form a completely vapor sealed insulation system.
2. Insulation shall be banded with metal bands.

K. High Temperature Pipe Insulation:
1. Install in multiple layers to meet thickness scheduled.
2. Attach each layer with bands. Secure first layer with bands before installing next layer.
3. Stagger joints between layers.
4. Finish with canvas jacket sized for finish painting.

L. Pipe Exposed in Mechanical Equipment Rooms less than 10’ above finished floor or Finished Spaces: Finish with PVC jacket and fitting covers.

M. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o’clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

N. Pipe Exposed in Clean Rooms: Finish with PVC jacket and fitting covers and sealed with FDA grade silicone.

3.3 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Hot Fluids 140 degrees F Or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140degrees F:
1. Insulate flanges and unions with removable sections and jackets.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.

H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

3.4 INSTALLATION - DUCTWORK SYSTEMS

A. Duct dimensions indicated on Drawings are finished inside dimensions.

B. Insulated ductwork conveying air below ambient temperature:
1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:
1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. External Glass Fiber Duct Insulation:
1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

E. Duct Liner:
1. Adhere insulation with adhesive for 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

3.5 SCHEDULES

A. Refer to the drawings for Pipe and Duct Insulation Schedules.

B. Equipment Insulation Schedule:

| EQUIPMENT | INSULATION TYPE | INSULATION THICKNESS inches |
|---|---|---|
| Heating Hot Water Pump Bodies | E-2 | 2.0 |
| Heating Hot Air Separators | E-1 | 2.0 |

| | | |
|---|---|---|
| Heating Hot Expansion Tanks | E-1 | 2.0 |
| Chilled Water Pump Bodies | E-2 | 2.0 |
| Chilled Water Air Separators | E-2 | 2.0 |
| Chilled Water Expansion Tanks | E-2 | 2.0 |

**END OF SECTION**

# SECTION 23 08 00 - COMMISSIONING OF HVAC

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Commissioning description.
2. Commissioning responsibilities.

### 1.2 REFERENCES

A. Associated Air Balance Council:
1. AABC - AABC Commissioning Guideline.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE Guideline 1 - The HVAC Commissioning Process.

C. National Environmental Balancing Bureau:
1. NEBB - Procedural Standards for Building Systems Commissioning.

### 1.3 COMMISSIONING DESCRIPTION

A. The commissioning process includes the following tasks:
1. Testing and startup of HVAC equipment and systems.
2. Equipment and system verification checks.
3. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
4. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
5. Provide operation and maintenance information and record drawings to Engineer for review verification and organization, prior to distribution.
6. Provide training of Owner’s staff for systems specified in this Section.

B. Equipment and Systems to Be Commissioned:
1. Pumps.
2. Heating water boilers.
3. Piping systems.
4. Variable frequency drives.
5. Humidifiers.
6. Air handling units.
7. Fan Coil Units.
8. Constant volume terminal units.
9. Variable volume terminal units.
10. Venturi air valves.
11. Supply, return, and exhaust air valves.
12. HEPA filtration.
13. Fans.

14. Laboratory room air balances.
15. Fire dampers.
16. Smoke detectors.
17. Equipment sound control.
18. Equipment vibration control.
19. Automatic temperature control system.
20. Testing, Adjusting and Balancing work.

1.4 COMMISSIONING SUBMITTALS

A. Draft Forms: Submit draft of system verification form and functional performance test checklist.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.

B. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.6 COMMISSIONING RESPONSIBILITIES

A. Equipment or System Installer Commissioning Responsibilities:
1. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
2. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
3. Provide instructions and demonstrations for Owner's personnel.
4. Ensure subcontractors perform assigned commissioning responsibilities.
5. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
6. Develop startup and initial checkout plan using manufacturer’s startup procedures and functional performance checklists for equipment and systems to be commissioned.
7. During verification check and startup process, execute portions of checklists for equipment and systems to be commissioned.
8. Perform and document completed startup and system operational checkout procedures.
9. Provide manufacturer’s representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
10. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
11. Provide personnel for equipment or system verification checks and performance tests.
12. Prior to performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
13. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
14. Perform verification checks and startup on equipment and systems as specified.
15. Perform operation and maintenance training sessions.

B. Temperature Controls Installer Commissioning Responsibilities:
   1. Review design for ability of systems to be controlled including the following:
      a. Confirm proper hardware requirements exists to perform functional performance testing.
      b. Confirm proper safeties and interlocks are included in design.
      c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
      d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
      e. Confirm sensors selected are within device ranges.
      f. Review sequences of operation and obtain clarification from Architect/Engineer.
      g. Indicate delineation of control between packaged controls and building automation system, listing BAS monitor points and BAS adjustable control points.
      h. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.
   2. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.
   3. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Commissioning Authority and Architect/Engineer.
   4. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
   5. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan.
   6. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
   7. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
   8. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.
   9. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

C. Testing, Adjusting, and Balancing Agency Commissioning Responsibilities:
   1. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes.
   2. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

## 1.7 COMMISSIONING MEETINGS

A. Attend commissioning meetings and progress meetings as required by the General Contractor.

## 1.8 SCHEDULING

A. Prepare schedule indicating anticipated start dates for the following:
   1. Piping system pressure testing.
   2. Piping system flushing and cleaning.
   3. Ductwork cleaning.
   4. Ductwork pressure testing.
   5. Equipment and system startups.

6. Automatic temperature control system checkout.
7. Testing, adjusting, and balancing.
8. HVAC and Clean Utilities system orientation and inspections.
9. Operation and maintenance manual submittals.
10. Training sessions.

1.9 COORDINATION

A. Notify General Contractor minimum of two weeks in advance of the following:
   1. Scheduled equipment and system startups.
   2. Scheduled automatic temperature control system checkout.
   3. Scheduled start of testing, adjusting, and balancing work.

B. Coordinate programming of automatic temperature control system with construction and commissioning schedules.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required by Commissioning Authority.

B. Place HVAC and Clean Utilities systems and equipment into full operation and continue operation during each working day of commissioning.

C. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.

D. Install test holes in ductwork and plenums as requested by Commissioning Authority for taking air measurements.

E. Prior to start of functional performance test, install replacement filters in equipment.

3.2 COMMISSIONING

A. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.

B. Occupancy Sensitive Functional Performance Tests:
   1. Test equipment and systems affected by occupancy variations at minimum and peak loads to observe system performance.
   2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.

**END OF SECTION**

# SECTION 232113 - HYDRONIC PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Joining materials.
4. Transition fittings.
5. Dielectric fittings.
6. Direct-buried pre-insulated piping systems.
7. Bypass chemical feeder.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:
1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.
5. Bypass chemical feeder.
6. Direct-buried pre-insulated piping systems.

B. Delegated-Design Submittal:
1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.
5. Factory-fabricated and designed, pre-insulated, HDPE-jacketed steel piping systems including pipe, fittings, and expansion / contraction compensation. Submittal to include piping system drawings in AutoCAD, component / materials submittals, thermal expansion / contraction stress analysis and compensation design, thrust block design, and installation instructions.

### 1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
   2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

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

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Hot-Water Heating Piping: 100 psig at 200 deg F.
   2. Chilled-Water Piping: 150 psig at 73 deg F.
   3. Glycol Cooling-Water Piping: 150 psig at 150 deg F.
   4. Makeup-Water Piping: 150 psig at 73 deg F.
   5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type L.

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

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

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

E. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

F. Wrought Copper Unions: ASME B16.22.

G. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.
1. Description: Tee formed in copper tube in accordance with ASTM F2014. Pulled tees can be any size up to a maximum of one size smaller than the main size.

H. Copper-Tube, Pressure-Seal-Joint Fittings:
1. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
2. Minimum 200-psig working-pressure rating at 250 deg F.

## 2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as scheduled on the plans.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as scheduled on the plans.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as scheduled on the plans.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as scheduled on the plans.

E. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
1. Material Group: 1.1.
2. End Connections: Butt welding unless threaded is called out on the plans.
3. Facings: Raised face.
   a. Flat face flanges where connecting to cast iron flanges.

G. Grooved Mechanical-Joint Fittings and Couplings:
1. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
2. Couplings: Ductile- or malleable-iron housing and EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

H. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed, threaded on both ends.

I. Steel Pipe Shaped Nipples: Pipe nipples shaped and beveled on one end for branch taps in lieu of tee fittings. Nipples and the shaped and beveled hole in the run pipe shall be shop-fabricated on a 5-axis plasma cutter.

1. Shaped nipple side taps may be used in pipe sizes up to 1/2 the size of the run pipe.
2. Pipe nipple material and schedule shall match the run pipe.
3. Bonney Forge Sweepolets may also be used.

J. Forged Steel Branch Taps: Forged steel full penetration butt-weld fittings for branch taps up to NPS 4.
1. MSS SP-97, ASME B16.11 and ASME B31, class 3000. Outlet configuration as required: butt weld, threaded, socket weld.
2. Equal to Bonney Forge "Olet" fittings.

## 2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

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

## 2.5 DIELECTRIC FITTINGS

A. Dielectric fittings are covered in 230000 General Mechanical Requirements

## 2.6 BYPASS CHEMICAL FEEDER

A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

## 2.7 DIRECT-BURIED PRE-INSULATED PIPING SYSTEMS

A. Pre-insulated Piping System:
1. Furnish a complete HDPE-jacketed system of factory-designed and fabricated pre-insulated steel piping where shown on the Drawings. All pre-insulated pipe, fittings, insulating materials, and technical support shall be provided by the pre-insulated piping system manufacturer.

2. The system shall be Ferro-Therm as manufactured by Thermacor Process Inc. of Fort Worth, Texas, or Engineer-approved equivalent.

B. Carrier Pipe shall be as scheduled on the Drawings.

C. Insulation shall be polyurethane foam either spray-applied or high pressure injected with one shot into the annular space between carrier pipe and jacket. Insulation shall be rigid, 90% minimum closed cell polyurethane with a minimum 2.0 lbs. per cubic foot density, compressive strength of 30 psi, and coefficient of thermal conductivity (K- Factor) of not higher than 0.16 @ 75°F per ASTM C-518. Maximum operating temperature shall not exceed 250°F. Insulation thickness shall be as scheduled on the Drawings.

D. Jacketing material shall be extruded, black, high density polyethylene (HDPE), having a minimum wall thickness not less than 100 mils for pipe sizes less than or equal to 12”, 125 mils for jacket sizes larger than 12” to 24”, and 150 mils for jacket sizes greater than 24”. No tape jacket allowed. The inner surface of the HDPE jacket shall be oxidized by means of corona treatment, flame treatment, or other approved methods. This will ensure a secure bond between the jacket and foam insulation preventing any ingression of water at the jacket/ foam interface.

E. Straight run joints shall be field-insulated per the manufacturer’s instructions, using polyurethane foam poured in an HDPE sleeve and sealed with a heat shrink sleeve. Pressure-testable joint closures shall be provided where indicated on the Drawings. All joint closures and insulation shall occur at straight sections of pipe. All insulation and jacketing materials shall be furnished by the same manufacturer.

F. Fittings shall be factory pre-fabricated and pre-insulated with polyurethane foam to the thicknesses specified on the Drawings and jacketed with a one-piece seamless molded HDPE fitting cover, a butt fusion welded, or an extrusion welded and mitered HDPE jacket. Carrier pipe fittings shall be butt-welded, except sizes smaller than 2” shall be socket-welded. Fittings shall be pre-fabricated / pre-engineered. Fittings include expansion loops, elbows, tees, reducers, and anchors. Elbows, loops, offsets, or any other direction changes shall conform to the standards set by ANSI B31.1, Code for Power Piping.

G. Expansion/contraction compensation will be accomplished utilizing factory pre-fabricated and pre-insulated expansion elbows, Z-bends, expansion loops, and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch thickness), extending on either side, both inside and outside the radius of the fittings are used with all fittings having expansion in excess of 1/2".

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

A. Piping system materials for hydronic piping applications are scheduled on the plans.

B. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

C. Air-Vent Piping:
   1. Inlet: Same materials and joining methods as for piping specified for the service in which the air vent is installed.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

D. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

## 3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

## 3.3 INSTALLATION OF PIPING

A. 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.

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

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

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

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

S. Comply with requirements in other Division 23 sections for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

T. Comply with requirements in other Division 23 sections for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in other Division 23 sections.

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in other Division 23 sections,

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in other Division 23 sections.

## 3.4 JOINT CONSTRUCTION

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

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

C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

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

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

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

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

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tools and procedure, and brazed joints.

J. Pressure-Sealed Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

## 3.5 INSTALLATION OF DIELECTRIC FITTINGS

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

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

C. Dielectric Fittings for NPS 2-1/2 and larger: Use dielectric flange kits.

## 3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in other Division 23 sections.

B. Comply with requirements in other Division 23 sections for hangers, supports, and anchor devices.

C. Install hangers for copper tubing and steel piping with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

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

E. Support vertical runs of copper tubing and steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

## 3.7 INSTALLATION OF DIRECT-BURIED PRE-INSULATED PIPING SYSTEMS

A. Unless noted otherwise on the Drawings, underground piping systems shall be buried in a trench not less than two feet deeper than the top of the pipe and not less than eighteen inches wider than the combined O.D. of all piping systems. A minimum thickness of 24 inches of compacted backfill placed over the top of the pipe will meet H-20 highway loading.
   1. Do not install underground piping when bedding is wet or frozen.

B. Trench bottom shall have a minimum of 6" of sand, pea gravel, or specified backfill material as a cushion for the piping. All field cutting of the pipe shall be performed in accordance with the manufacturer's installation instructions.

C. Field Service, if required, shall be provided by a certified manufacturer's representative or company field service technician. The technician will be available at the job a minimum of one day (or more if required by job size) to check unloading, storing, and handling of pipe, pipe installation, pressure testing, field joint insulation, and backfilling techniques.

## 3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in other Division 23 sections.

## 3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in other Division 23 sections.

## 3.10 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

**END OF SECTION**

# SECTION 23 21 16 - HYDRONIC PIPING SPECIALTIES

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Liquid flow meters.
2. Pressure gages.
3. Pressure gage taps.
4. Thermometers.
5. Thermometer supports.
6. Test plugs.
7. Flexible connectors.
8. Expansion tanks.
9. Air vents.
10. Air separators.
11. Strainers.
12. Pump suction fittings.
13. Flow controls.
14. Relief valves.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:
1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.
2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

C. American Water Works Association:
1. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
2. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
3. AWWA C702 - Cold-Water Meters - Compound Type.
4. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
5. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

D. Underwriters Laboratories Inc.:
1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

### 1.3 PERFORMANCE REQUIREMENTS

A. Flexible Connectors: Provide at or near where piping configuration does not absorb vibration.

### 1.4 SUBMITTALS

A. Product Data: Submit for manufactured products and assemblies used in this Project.

1. Manufacturer’s data indicating use, operating range, total range, accuracy, and location for manufactured components.
2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
4. Submit electrical characteristics and connection requirements.

B. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of actual locations of components and instrumentation, and flow meters.

B. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.8 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

1.9 WARRANTY

A. Furnish two year manufacturer warranty for piping specialties.

1.10 EXTRA MATERIALS

A. Furnish one extra 10 gallon drum of propylene glycol.

PART 2 PRODUCTS

2.1 LIQUID FLOW METERS

A. Manufacturers:
1. Rosemount 8700 Series.
2. Omega FMG600 Series.
3. Badger M2000 Series.
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Magnetic Flow Meter: Welded carbon steel housing with 304 stainless steel sensor and PTFE lining. Provide with remote mounted signal transmitter with digital display.
1. Pressure rating: 275 psi.
2. Maximum temperature: 350 degrees F.
3. Accuracy: Plus 0.25 percent.

2.2 PRESSURE GAGES

A. Gage: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
1. Case: Steel, except in cleanroom spaces which shall have a stainless steel case.
2. Bourdon Tube: Brass.
3. Dial Size: 2 inch diameter.
4. Mid-Scale Accuracy: One percent.
5. Scale: Psi.
6. Range: Appropriate for the intended service.

2.3 PRESSURE GAGE TAPS

A. Ball Valve: Brass, except in cleanroom spaces which shall be stainless steel, 1/4 inch NPT for 250 psi.

2.4 STEM TYPE THERMOMETERS

A. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
1. Size: 7 inch scale.
2. Window: Clear glass.
3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
4. Accuracy: ASTM E77 2 percent.
5. Calibration: Both degrees F and degrees C.
6. Range: Appropriate for the intended service.

2.5 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions.

2.6 TEST PLUGS

A. 1/4 inch NPT or 1/2 inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with:
   1. Neoprene core for temperatures up to 200 degrees F.
   2. Nordel core for temperatures up to 350 degrees F.
   3. Viton core for temperatures up to 400 degrees F.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Metraflex.
   2. Mason Industries.
   3. Flexicraft Industries.
   4. Flex-hose Co, Inc.
   5. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 300 psig.

2.8 EXPANSION TANKS

A. Manufacturers:
   1. Amtrol.
   2. Bell & Gossett.
   3. Taco.
   4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Construction: Full acceptance bladder design, closed, welded steel, tested and stamped in accordance with ASME Section VIII; cleaned, prime coated, and supplied with steel support saddles; with taps for installation of accessories.
   1. Pressure rating: 125 psi.

C. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 12 psig.

D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure back flow prevention device, test cocks, strainer, vacuum breaker, and by-pass valves.

2.9 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

B. Float Type:
   1. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.10 AIR SEPARATORS

A. Manufacturers:
   1. Spirotherm.

2. Thrush.
3. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. In-line Air Separators: Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; tested and stamped in accordance with ASME Section VIII; for 125 psig operating pressure.

2.11 STRAINERS

A. Manufacturers:
1. Keckley.
2. Armstrong.
3. Nibco.
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Size 2 inch and Smaller:
1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch and larger:
1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.12 PUMP SUCTION FITTINGS

A. Manufacturers:
1. Bell and Gossett.
2. Keckley.
3. Taco.
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Fitting: Angle pattern, cast-iron body. Threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger. Rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blow-down tapping in bottom, gage tapping in side.

2.13 RELIEF VALVES

A. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

PART 3 EXECUTION

3.1 INSTALLATION - THERMOMETERS AND GAGES

A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.

B. Install gage taps in piping

C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage. Extend nipples to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.

E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.

F. Coil and conceal excess capillary on remote element instruments.

G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Locate test plugs adjacent to thermometers and thermometer sockets.

B. Where large air quantities accumulate, provide enlarged air collection standpipes.

C. Install manual air vents at system high points.

D. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

E. Provide air/dirt separator on suction side of system circulation pump and connect to expansion tank.

F. Provide drain and hose connection with valve on strainer blow down connection.

G. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.

H. Support pump fittings with floor mounted pipe and flange supports.

I. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

J. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

K. Pipe relief valve outlet to nearest floor drain.

L. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

M. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.

3.3 FIELD QUALITY CONTROL

A. Test for strength of glycol and water solution and submit written test results.

3.4 CLEANING

A. Clean and flush glycol system before adding glycol solution.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Do not install hydronic pressure gauges until after systems are pressure tested.

**END OF SECTION**

# SECTION 23 21 23 - HYDRONIC PUMPS

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. In-line Pumps.
   2. Base mounted pumps.

### 1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Underwriters Laboratories Inc.:
   1. UL 778 - Motor Operated Water Pumps.

### 1.3 PERFORMANCE REQUIREMENTS

A. Provide pumps to operate at system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

### 1.4 SUBMITTALS

A. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.

B. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

### 1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 WARRANTY

A. Furnish two-year manufacturer warranty for pumps.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Bell & Gossett.
   2. Armstrong.
   3. Paco.
   4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

2.2 IN-LINE PUMPS

A. Type: Single stage, close coupled, radial or horizontally split casing, for in-line mounting, for 175 psig working pressure.

B. Casing: Cast iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.

C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.

D. Shaft: Carbon steel with stainless steel impeller cap screw or nut.

E. Shaft Sleeve: Aluminum bronze.

F. Seal: Carbon rotating against stationary ceramic seat, 225 degrees F maximum continuous operating temperature.

G. Electrical Characteristics and Components:
   1. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.3 BASE MOUNTED PUMPS

A. Reference PUMP SCHEDULE in drawings.

B. Provide inertia base when required on drawings.

C. Type: Horizontal shaft, single stage, direct connected, radial or horizontal split casing, for 125 psig maximum working pressure.

D. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

E. Impeller: Bronze, fully enclosed, keyed to shaft.

F. Bearings: Grease lubricated roller or ball bearings.

G. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

H. Seal: Carbon rotating against stationary ceramic seat, 225 degrees F maximum continuous operating temperature.

I. Drive: Flexible coupling with coupling guard.

J. Baseplate: Cast iron or fabricated steel with integral drain rim.

K. Electrical Characteristics and Components:
1. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
2. Provide shaft grounding rings on pumps controlled by a variable frequency drive.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes 4 inches and over.

C. Install pumps on vibration isolators.

D. Install the following accessories:
1. On Suction:
   a. Pressure gage
   b. Isolation Valve
   c. Strainer (unless condenser water pump, then install strainer on discharge)
2. On Discharge:
   a. Pressure gage
   b. Check Valve
   c. Balancing Valve
   d. Isolation Valve

E. Install flexible connectors at or near pumps where piping configuration does not absorb vibration.

F. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.

G. Provide air cock and drain connection on horizontal pump casings.

H. Provide drains for bases and seals.

I. Check, align, and certify alignment of base mounted pumps prior to start-up.

J. Install base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place.

K. Lubricate pumps before start-up.

3.2 FIELD QUALITY CONTROL

A. Inspect for alignment of base mounted pumps.

**END OF SECTION**

# SECTION 23 31 00 - HVAC DUCTS AND CASINGS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Duct Materials.
2. Flexible ducts.
3. Insulated flexible ducts.
4. Single wall spiral round ducts.
5. Casings.
6. Ductwork fabrication.
7. Duct cleaning.

### 1.2 REFERENCES

A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
4. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
5. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
6. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
7. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
8. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
9. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
10. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

C. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - Fibrous Glass Duct Construction Standards.
   2. SMACNA - HVAC Air Duct Leakage Test Manual.
   3. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

D. Underwriters Laboratories Inc.:
   1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 PERFORMANCE REQUIREMENTS

A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 SUBMITTALS

A. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/8 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
   1. Duct layout inside and on roof.
   2. Penetrations through fire rated and other walls.
   3. Roof penetrations.
   4. Roof curbs.
   5. Equipment installations.

B. Product Data: Submit data for duct materials, duct liner, and exterior aluminum waterproof jacket.

C. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

B. Perform work in accordance with ASHRAE Standards and Guidelines.

C. Construct ductwork to NFPA 90A standards.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealant.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

**PART 2 PRODUCTS**

2.1 DUCT MATERIALS

A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G60 zinc coating in conformance with ASTM A90/A90M.

B. Stainless Steel Ducts: ASTM A240/A240M or ASTM A666, Type 304

C. Fasteners: Rivets, bolts, or sheet metal screws.

D. Hanger Rod: ASTM A36/A36M; steel, galvanized; continuously threaded.

2.2 INSULATED FLEXIBLE DUCTS

A. Manufacturers:
1. Thermaflex
2. Ameriflex
3. Flexmaster USA
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Product Description: Two ply vinyl film supported by helical wound spring steel wire; fiberglass insulation; aluminized vapor barrier film.
1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -10 degrees F to 140 degrees F.
4. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.

2.3 SINGLE WALL SPIRAL ROUND DUCTS

A. Product Description: Equivalent to UL 181, Class 1, round spiral lockseam duct constructed of galvanized steel.

2.4 DUCTWORK FABRICATION

A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards), and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

F. For rectangular duct, use 45 deg tap per SMACNA requirements.

G. For round duct, provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

H. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
   1. Sealants, Mastics and Tapes: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
   2. Do not provide sealing products not bearing UL approval markings.

I. Duct pressure ratings: Construct ductwork to the following pressure ratings:
   1. Supply, return, and exhaust ductwork on roof: 3 inches
   2. Supply, return, and exhaust ductwork interior to the building: 3 inches

## PART 3 EXECUTION

### 3.1 EXAMINATION

A. Verify sizes of equipment connections before fabricating transitions.

### 3.2 INSTALLATION

A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, seal class A.

B. Install glass fiber ducts in accordance with SMACNA Fibrous Glass Duct Construction Standards. Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.

C. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. Use double nuts and lock washers on threaded rod supports.

E. Connect flexible ducts to metal ducts with draw bands.

F. Exhaust Outlet Locations:
   1. Minimum Distance from Building Openings: 3 feet.
   2. Minimum Distance from Outside Air Intakes: 10 feet.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

B. Connect diffusers to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

C. Connect air terminal units to supply ducts directly or with five foot maximum length of flexible duct. Do not use flexible duct to change direction.

3.4 CLEANING

A. Existing ductwork: Clean all existing ductwork throughout the building. Clean existing ductwork after existing diffusers, registers, and grilles are demolished and before new diffusers, registers, and grilles are installed.

B. Clean all new ductwork after installation and before new diffusers, registers, and grilles are installed.

C. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.

D. Clean duct systems with high power vacuum machines. Protect equipment with potential to be harmed by excessive dirt with filters, or bypass during cleaning. Install access openings into ductwork for cleaning purposes.

E. Construction Waste: In accordance with Section 01 74 19.

3.5 TESTING

A. New ductwork: Pressure test all new ductwork after duct cleaning, but before duct insulation is applied or ductwork is concealed.
   1. Test in accordance with SMACNA HVAC Air Duct Leakage Test Manual.
   2. Maximum Allowable Leakage: In accordance with ICC IECC.

**END OF SECTION**

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# SECTION 23 33 00 - AIR DUCT ACCESSORIES

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Back-draft dampers.
2. Duct access doors.
3. Volume control dampers.
4. Flexible duct connections.
5. Duct test holes.
6. Combination fire and smoke dampers
7. Dynamic fire dampers

### 1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 92A - Recommended Practice for Smoke-Control Systems.

D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. ASHRAE Standards and Guidelines

F. Underwriters Laboratories Inc.:
1. UL 555 - Standard for Safety for Fire Dampers.
2. UL 555C - Standard for Safety for Ceiling Dampers.
3. UL 555S - Standard for Safety for Smoke Dampers.

### 1.3 SUBMITTALS

A. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
1. Backdraft dampers.
2. Flexible duct connections.
3. Volume control dampers.
4. Duct access doors.
5. Duct test holes.

B. Product Data: For fire dampers and combination fire and smoke dampers, submit the following:
   1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
   2. Indicate materials, construction, dimensions, and installation details.
   3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of access doors.

B. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.5 QUALITY ASSURANCE

A. Dampers tested, rated and labeled in accordance with the latest UL requirements.

B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

C. Storage: Store materials in a dry area indoor, protected from damage.

D. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.7 WARRANTY

A. Furnish 2 year manufacturer’s warranty for all air duct accessories.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 COORDINATION

A. Coordinate work where appropriate with building automatic temperature controls work.

**PART 2 PRODUCTS**

2.1 BACK-DRAFT DAMPERS

A. Manufacturers:
   1. Greenheck
   2. Ruskin

3. Pottorff
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized 16 gage thick steel. Blades, maximum 6 inch width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.
1. Back-draft dampers used in laboratory exhaust systems shall be constructed of the same material as the duct in which they reside.

## 2.2 DUCT ACCESS DOORS

A. Manufacturers:
1. Ruskin
2. Greenheck
3. Ductmate
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Fabrication: Rigid and close fitting of construction material matching duct system, with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
1. Less than 12 inches square, secure with sash locks.
2. Up to 18 inches Square: Furnish two hinges and two sash locks.
3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Furnish additional hinge.
5. Sash Lock: By manufacturer.
6. Compression Latch: By manufacturer.
7. Hinge: By manufacturer.
8. Access panels with sheet metal screw fasteners are not acceptable.

## 2.3 VOLUME CONTROL DAMPERS

A. Manufacturers:
1. Greenheck
2. Ruskin
3. Nailor
4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.

D. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg.

E. Saw cut end of damper shaft to indicate blade orientation.

F. Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches furnish regulator at both ends.

## 2.4 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

B. Connector: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
2. Net Fabric Width: Approximately 3 inches wide.
3. Metal: 3 inch wide, 24 gage galvanized steel.

## 2.5 DUCT TEST HOLES

A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

## 2.6 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
1. Ruskin
2. Greenheck
3. Nailor

B. Fabricate in accordance with NFPA 90A, UL 555, and UL 555S.

C. Fire Resistance: HVAC penetrations through barriers with fire resistance ratings less than 3 hours shall be protected by 1-1/2 hour rated fire dampers and penetrations through barriers with fire resistance ratings of 3 hours or more shall be protected by 3 hour rated fire dampers.

D. Leakage Rating: Class II, maximum of 20 cfm at 4 inches wg differential pressure.

E. Damper Temperature Rating: 250 degrees F.

F. Frame: 16 gage, galvanized steel.

G. Blades:
1. Style: Single skin with 3 longitudinal grooves.
2. Action: Opposed.
3. Orientation: Horizontal.

4. Material: Minimum 14 gage equivalent thickness, galvanized steel.
5. Width: Maximum 6 inches.

H. Bearings: Stainless steel pressed into frame.

I. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.

J. Linkage: Concealed in frame.

K. Release Device: Close in controlled manner and allow damper to be automatically reset.

L. Actuator:
1. Type: Electric 120 volt, 60 hertz, two-position, fail close. Coordinate with Electrical Contractor.
2. Mounting: External.

M. Fusible Link Release Temperature: 165 degrees F.

N. Finish: Mill galvanized.

O. Factory installed sleeve. Furnish silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

## 2.7 DYNAMIC FIRE DAMPERS

A. Manufacturers:
1. Greenheck
2. Ruskin
3. Nailor

B. Fabricate in accordance with NFPA 90A and UL 555.

C. Fire Resistance: HVAC penetrations through barriers with fire resistance ratings less than 3 hours shall be protected by 1-1/2 hour rated fire dampers and penetrations through barriers with fire resistance ratings of 3 hours or more shall be protected by 3 hour rated fire dampers.

D. Dynamic Closure Rating: Dampers classified for dynamic closure to 2000 fpm and 4 inches wg static pressure.

E. Construction:
1. Integral Sleeve Frame: Minimum 20 gage roll formed galvanized steel. Length: 12 inches.
2. Blades:
   a. Style: Curtain type.
   b. Action: Spring or gravity closure upon fusible link release.
   c. Material: Minimum 24 gage roll formed, galvanized steel.
3. Closure Springs: Type 301 stainless steel, constant force type, if required.

F. Fusible Link Release Temperature: 165 degrees F.

G. Mounting: Vertical or horizontal as indicated on Drawings.

H. Duct Transition Connection, Damper Style: Frame and Blades to be outside of airstream.

I. Finish: Mill galvanized.

**PART 3 EXECUTION**

3.1 EXAMINATION

A. Verify rated walls are ready for fire damper installation.

B. Verify ducts and equipment installation are ready for accessories.

C. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

A. Install all duct accessories in accordance with manufacturer's requirements, in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.

C. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing; install in accessible locations, and include manual quadrant regulators. Use splitter dampers only where indicated.

D. Provide flexible connections in ducts immediately adjacent to equipment associated with fans and motorized equipment. Cover connections to medium and high pressure fans with leaded vinyl sheet, held in place with metal straps.

E. Access Doors: Install access doors at the following locations and/or as indicated on Drawings:
1. Upstream of each reheat coil.
2. Before and after each duct mounted filter.
3. Before and after each duct mounted coil.
4. Before and after each duct mounted fan.

F. Access Door Sizes: Install minimum 8 x 8 inch size for hand access in ducts smaller than 24", and 18 x 18 inch size for shoulder access in ducts 24" and larger, and/or as indicated on Drawings. Review locations prior to fabrication.

G. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

H. Install fire dampers and combination fire and smoke dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

1. Install combination smoke and fire dampers in accordance with NFPA 92A.
2. Install dampers square and free from racking with blades running horizontally.
3. Do not compress or stretch damper frame into duct or opening.
4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

## 3.3 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

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# SECTION 23 34 00 - HVAC FANS

## PART 1 GENERAL

1.1 SUMMARY

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

B. Section Includes:
1. Centrifugal fans.
2. Upblast centrifugal roof fans.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:
1. AMCA 99 - Standards Handbook.
2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Refrigeration Institute:
1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.

D. ASTM International:
1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

E. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. Underwriters Laboratories Inc.:
1. UL 705 - Power Ventilators.

1.2 SUBMITTALS

G. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

H. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and

outlet at rated capacity, electrical characteristics, and connection requirements. Include data and options defined in SCHEDULES in the drawings.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.4 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300,and bear AMCA Certified Sound Rating Seal.

C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

D. Balance Quality: Conform to AMCA 204.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.7 EXTRA MATERIALS

A. Furnish two sets of belts for each fan.

**PART 2 PRODUCTS**

2.1 MANUFACTURERS

1. Basis of Design: Greenheck Corporation
2. Acceptable Manufacturers:
    a. MK Plastics.
    b. Strobic Air Corporation.
    c. Acme Engineering and Manufacturing Corp.
    d. Loren Cook Company.
    e. Twin City Fan and Blower.
    f. Chicago Blower Corporation.
    g. PennBarry.
3. Substitution: With engineer approval

2.2 CENTRIFUGAL FANS – GENERAL REQUIREMENTS

A. See drawings (SCHEDULES and DETAILS) for performance requirements, options, and other requirements.

B. Performance:
   1. Project Elevation: 5315 Feet.
   2. Temperature Limit: Maximum 150 degrees F.
   3. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

C. Wheel and Inlet:
   1. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, back plate, backward curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
   2. Forward Curved: Galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to back plate and keyed to shaft with set screw.
   3. Airfoil Wheel: Steel construction with smooth curved inlet flange, back plate die formed hollow airfoil shaped blades continuously welded at tip flange, and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

D. Housing:
   1. Steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, braced, designed to minimize turbulence with spun inlet bell and shaped cut-off.
   2. Factory finish before assembly to manufacturer's standard. For fans handling air downstream of humidifiers, furnish two additional coats of paint. Prime coating on aluminum parts is not required.
   3. Fabricate plug fans without volute housing, in lined steel cabinet.

E. Bearings and Sleeves:
   1. Bearings: Pillow block type, self-aligning, grease-lubricated roller bearings, or ABMA 11, L-10 life at 120,000 hours.
   2. Shafts: Hot rolled steel, ground and polished, with key way, protectively coated with lubricating oil, and shaft guard.
   3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
   4. Belt Guard: Fabricate to SMACNA Standard; 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

F. Accessories:
   1. Discharge Dampers: Opposed blade steel damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.
   2. Inlet/Outlet Screens: Galvanized steel welded grid.
   3. Access Doors: Shaped to conform to scroll, with quick opening latches and gaskets.
   4. Scroll Drain: 1/2 inch steel pipe coupling welded to low point of fan scroll.
   5. Vibration isolators: restrained isolators to allow 1 inch deflection.

2.3 LABORATORY EXHAUST CENTRIFUGAL ROOF FANS – ADDITIONAL REQUIREMENTS

A. Fan Unit: Utility Set type. V-belt or direct drive. See SCHEDULE for required materials for fan and housing. Resilient mounted motor. Provide roof supports and vibration isolation attachment to supports.

B. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; provide constant pitch sheave for final balance; provide fan shaft with self-aligning pre-lubricated ball bearings.

C. Roof Supports: By fan manufacturer. See SCHEDULE on drawings. Select height of supports so that the top of the support is 12 inches above the roof. See details in drawings (architectural, structural, and mechanical).

D. Accessories:
1. Motor Operated Damper: Material same as ductwork. Multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked and line voltage motor drive, power open and closed.

**PART 3 EXECUTION**

3.1 EXAMINATION

A. Verify roof curbs and/or supports are installed as instructed by manufacturer. Verify dimensions are correct.

3.2 INSTALLATION

A. Secure roof fans to roof supports. Secure supports to roof structure. See details in architectural, structural, and mechanical drawings. Coordinate with the General Contractor.

B. Provide flexible connections between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running. Exterior flexible connections shall be waterproof. Use stainless steel for bands and connections.

C. Install safety screen where inlet or outlet is exposed.

D. Pipe scroll drains to nearest roof drain.

E. Provide sheaves required for final air balance.

3.3 CLEANING

A. Vacuum clean inside of fan cabinet.

B. Construction Waste: In accordance with Section 01 74 19.

3.4 DEMONSTRATION

A. Demonstrate fan operation and maintenance procedures.

3.5 PROTECTION OF FINISHED WORK

A. Do not operate fans until ductwork is clean, filters are in place, bearings are lubricated, and fan has been test run under observation.

**END OF SECTION**

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# SECTION 23 36 00 - AIR TERMINAL UNITS

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Variable volume terminal units.

### 1.2 REFERENCES

A. American Refrigeration Institute:
   1. ARI 880 - Air Terminals.
   2. ARI 885 -Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. National Fire Protection Association:
   1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

D. Underwriters Laboratories Inc.:
   1. UL 181 - Factory-Made Air Ducts and Connectors.

### 1.3 SUBMITTALS

A. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, heating coil capacity and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

### 1.5 QUALITY ASSURANCE

A. Test and rate air terminal units performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.

### 1.6 WARRANTY

A. Furnish 2 year manufacturer’s warranty for terminal units.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
1. Carrier
2. Titus.
3. Nailor Industries.
4. Price Industries.
5. Krueger
6. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

2.2 SINGLE DUCT VARIABLE VOLUME AIR TERMINAL UNITS

A. Product Description: Variable air volume terminal units for connection to central air systems, with electronic controls.

B. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.

C. Basic Assembly:
1. Casings: Minimum 22 gage galvanized steel.
2. Lining: Minimum 1/2 inch thick closed cell foam fiber free insulation, 1.5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.
3. Air Inlets: Round stub connections for duct attachment.
4. Plenum Air Outlets: S slip-and-drive connections.

D. Basic Unit:
1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches inlet static pressure.
3. Mount damper operator to position damper normally open.
4. Airflow Sensor: Differential pressure airflow device measuring total, static, and velocity pressures, mounted to the inlet valve.

E. Automatic Damper Operator:
1. Electric Actuator: 24 volt.

F. Hot Water Heating Coil:
1. Coil Casing: Minimum 22 gauge, 0.032 inch (0.81 mm) galvanized steel, factory-installed on terminal discharge with slip-and drive attachment for downstream ductwork.

2. Handing of coil shall be specified as either right or left hand when looking into the coil inlet, in the direction of airflow.
3. Coil Fins: Aluminum 0.0045 inch ( 0.1143 mm) fins, mechanically-bonded to seamless 0.50 by 0.016 inch (12.7 by 0.40 mm) copper tubes.
4. Fins to be formed in a high heat transfer sine wave configuration.
5. Standard coil to be constructed of 10 fins-per-inch fin configuration.
6. High capacity coil to be constructed of 12 fins-per-inch fin configuration.
7. Coil leak tested to minimum 350 psig (2413 kPa).
8. Minimum Burst Pressure: 1800 psi (125 bar).
9. Certified in accordance with AHRI 410 and units to bear AHRI 410 label.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. Install ceiling access doors or locate units above easily removable ceiling components.

B. Support units individually from structure. Do not support from adjacent ductwork.

C. Support air terminal units connected by flexible duct independently of flexible duct.

D. Install transition piece to match flexible duct size to inlet or outlet of variable air volume terminal.

### 3.2 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow.

**END OF SECTION**

# SECTION 23 37 00 - AIR OUTLETS AND INLETS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
   1. Diffusers.
   2. Registers
   3. Grilles.

### 1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:
   1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

### 1.3 SUBMITTALS

A. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

B. Test Reports: Rating of air outlet and inlet performance.

### 1.4 QUALITY ASSURANCE

A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

### 1.5 WARRANTY

A. Furnish two year manufacturer warranty for air outlets and inlets.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers:
   1. Basis of Design: Titus
   2. Acceptable Manufacturers:
      a. E. H Price Company
      b. Nailor.
   3. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

2.2 RECTANGULAR CEILING DIFFUSERS

A. Type: Architectural square, panel, diffuser to discharge air in 360 degree pattern.

B. Frame: Inverted T-bar type. In gyp board ceilings, furnish appropriate mounting frame.

C. Fabrication: Aluminum with factory baked enamel off-white finish.

2.3 CEILING EXHAUST AND RETURN GRILLES

A. Type: Egg crate with ½’ grid and border.

B. Frame: Inverted T-bar type. In gyp board ceilings, furnish appropriate mounting frame.

C. Fabrication: Aluminum with factory baked enamel off-white finish.

2.4 WALL SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, horizontal face, double deflection.

B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.

C. Fabrication: Aluminum with 20 gage minimum frame, with factory off-white enamel finish.

D. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.5 WALL EXHAUST AND RETURN GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, horizontal hinged face to allow cleaning of back side of grille.

B. Frame: 1-1/4 inch margin with concealed mounting.

C. Fabrication: Aluminum with 20 gage minimum frame, with factory off-white enamel finish.

2.6 WALL EXHAUST AND RETURN FILTER GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, horizontal hinged face to allow cleaning of back side of grille, with frame for holding 2 inch HEPA filter.

B. Frame: 1-1/4 inch margin with concealed mounting.

C. Fabrication: Aluminum with 20 gage minimum frame, with factory off-white enamel finish.

## PART 3 EXECUTION

3.1 EXAMINATION

A. Verify inlet and outlet locations.

B. Verify ceiling and wall systems are ready for installation.

3.2 INSTALLATION

A. Install diffusers to ductwork with airtight connection.

B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

**END OF SECTION**

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# SECTION 23 40 00 - HVAC AIR CLEANING DEVICES

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
   1. Disposable, extended area panel filters.
   2. Extended surface high efficiency media filters.

### 1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   1. ARI 850 - Commercial and Industrial Air Filter Equipment.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

C. Military Standardization Documents:
   1. MIL MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components, and Related Products: Performance-Test Methods.

D. Underwriters Laboratories Inc.:
   1. UL 586 - High-Efficiency. Particulate, Air Filter Units.
   2. UL 900 - Air Filter Units.

### 1.3 PERFORMANCE REQUIREMENTS

A. Conform to ARI 850 Section 7.4.

B. Dust Spot Efficiency: Plus or minus 5 percent.

### 1.4 SUBMITTALS

A. Product Data: Submit data on filter media, filter performance data, dimensions, and electrical characteristics.

B. Manufacturer's Installation Instructions: Submit assembly and change-out procedures.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for operation, changing, and periodic cleaning.

### 1.6 WARRANTY

A. Furnish 2 year manufacturer’s warranty for all air cleaning devices.

1.7 EXTRA MATERIALS

A. Furnish one set of disposable panel filters for each air unit.

**PART 2 PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers:
   1. American Air Filter
   2. Flanders-Precisionaire
   3. Camfil Farr
   4. Substitutions: Per section 23 00 00 – General Mechanical Requirements.

2.2 DISPOSABLE, EXTENDED AREA PANEL FILTERS – MERV 8

A. Media: UL 900, pleated, lofted, non-woven, reinforced cotton fabric; supported by corrugated aluminum separators.
   1. Frame: Cardboard.
   2. Nominal thickness: 2 inches.

B. Rating, ASHRAE 52.1:
   1. Dust spot efficiency: 25-30 percent.
   2. Weight arrestance: 95-98 percent.
   3. Initial resistance at 500 fpm face velocity: 0.23 inch wg.
   4. Recommended final resistance: 1.0 inch wg.

2.3 EXTENDED SURFACE HIGH EFFICIENCY MEDIA FILTERS – MERV 13

A. Media: Pleated, water-resistant glass fiber with separators; in high wet strength cardboard holding frame.

B. Performance Rating, ASHRAE 52.1:
   1. Dust Spot Efficiency: 90 percent.
   2. Weight arrestance: 98 percent.
   3. Initial Resistance at 500 fpm face velocity: 0.75 inch wg.
   4. Recommended Final Resistance: 1.5 inch wg.

2.4 HEPA FILTERS

A. Alternate #3: Include as final filter in RTU-N1 and RTU-N3 in lieu of MERV 13.

B. Dust Spot Efficiency: 99.97% for 0.3 micron particles.

**PART 3 EXECUTION**

3.1 INSTALLATION

A. Install filters with felt, rubber, or neoprene gaskets to prevent passage of unfiltered air around filters.

B. Install filter gage static pressure tips upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level.

C. Do not operate fan system until temporary filters are in place. Replace temporary filters used during construction and testing, with clean set.

D. Install filter gages on filter banks with separate static pressure tips upstream and downstream of filters.

3.2 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

**END OF SECTION**

# SECTION 23 73 10 - OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section includes modular factory fabricated air-handling units and accessories. This specification covers the requirements for Air Handling Units (AHUs), and Make-Up Air Units (MAUs).

### 1.2 REFERENCES

A. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:
1. AMCA 99 - Standards Handbook.
2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
5. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. Air-Conditioning and Refrigeration Institute:
1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
2. ARI 430 - Central-Station Air-Handling Units.
3. ARI 610 - Central System Humidifiers for Residential Applications.
4. ARI Guideline D - Application and Installation of Central Station Air-Handling Units.

D. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.

E. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

F. Underwriters Laboratories Inc.:
1. UL 900 - Air Filter Units.
2. UL - Fire Resistance Directory.

### 1.3 SUBMITTALS

A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

B. Product Data, Submit the following:
1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.

4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
5. Dampers: Include leakage, pressure drop, and sample calibration curves. Indicate materials, construction, dimensions, and installation details.
6. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements. Provide line-by-line statement of compliance to this specification. Each paragraph shall be tagged with either a “C” for comply or a “D” for deviate. Any sections marked as “deviate” shall be accompanied with an explanation.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Protect units from weather and construction traffic by storing in dry, roofed location.

1.6 WARRANTY

A. Furnish 2 year manufacturer’s warranty for all air handling units.

1.7 EXTRA MATERIALS

A. Furnish one spare fan motor of each size used on the project.

PART 2 PRODUCTS

2.1 100% OA AIR HANDLING UNITS (OUTDOOR)

A. Manufacturers:
1. York/Johnson Controls.
2. Carrier
3. Substitutions: Per section 23 00 00 – General mechanical Requirements.

B. Configuration: Fan section plus accessories, including:
1. Filter section.
2. Preheating coil.
3. Cooling coil.
4. Humidifier.

C. Fabrication: Conform to AMCA 99.

D. Unit shall be provided completely assembled, or shipped in multiple sections and engineered for ease of field assembly. Field assembly shall be accomplished using factory provide gasket and bolts and not caulk. Each section shall include a permanent label to aid in proper field

assembly. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

E. Provide unit with tags or decals to aid in service or indicate caution areas.

F. Rigging Provisions for Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

2.2 100% OA RTU CASING

A. General: Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and ARI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems.” Units shall comply with NFPA 70, “National Electrical Code,” as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.

B. Rigging Provision – Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

C. Unit Base - Floor: Unit perimeter base shall be completely welded and fabricated using heavy gauge structural steel tubing. (Note: bolted bases are not acceptable) C-Channel cross supports shall be welded to perimeter base steel tubing and located on maximum 24” centers to provide support for internal components. Base rails shall include lifting lugs welded to perimeter base at the corner of the unit or each section if de-mounted. Entire base frame is to be painted with a phenolic coating for long term corrosion resistance. Internal walk-on floor shall be 16 gauge galvanized steel. The outer sub-floor of the unit shall be made from 20 gauge galvanized steel. The floor cavity shall be spray foam insulated with floor seams gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating. Single wall floors

with glued and pined insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.

D. Unit Casing – The construction of the air handling unit shall consist of a (1" x 2") steel frame with formed 16 gauge galvanized steel exterior casing panels. The exterior casing panels shall be attached to the gasketed (1 x 2) steel frame with corrosion resistant fasteners. All casing panels shall be completely removable from the unit exterior without affecting the unit's structural integrity. (Units without framed type of construction shall be considered, provided the exterior casing panels are made from 14 gauge galvanized steel, maximum panel center lines are less than 20 inches and deflection is less than L/200 @ 9" positive pressure). The air handling unit casing shall be of the "no-through-metal" design. The casing shall incorporate insulating thermal breaks as required so that, when fully assembled, there's no path of continuous unbroken metal to metal conduction from inner to outer surfaces. Provide necessary support to limit casing deflection to L/200 of the narrowest panel dimension. If panels cannot meet this deflection, additional internal reinforcing is required. All panel seams shall be caulked and sealed for an airtight unit. Leakage rates shall be less than 1% at design static pressure or 9" W.C. whichever is greater. Unit shall be outdoor construction, with exterior paint and corrosion protection.

E. Double Wall Liner - Each unit shall have double wall construction with 20 gauge solid galvanized liner in the entire unit. The double wall interior panel shall be removable from the outside if the unit without affecting the structural integrity of the unit.

F. Insulation - Entire unit to be insulated with a full (R20) 3" thick closed cell foam insulation. Foam shall be ecomate 0-, 0-, (Non VOC) UL 94HF1 rated. All insulation edges shall be encapsulated within the panel. All field penetrations must be completely sealed by installing contractor.

G. Access Doors - The unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged access doors as shown on the plans. The doorframe shall be extruded aluminum, foam filled with a built in thermal break barrier and full perimeter gasket. The door hinge assembly shall be completely adjustable die cast stainless steel. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.

Note: If manufacturer cannot provide thermal break door design it must be noted as an exception on the bid.

2.3 100% OA RTU FANS

A. Each air handling unit shall utilize a multiple fan array system consisting of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified, class III construction as required. Class I fans are not acceptable. Fans shall be rated in accordance with AMCA 210 for performance, and be certified by AMCA. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed.
   1. Each fan/motor cube or cell shall include a minimum 10 gauge, G 90 Galvanized steel intake wall, .100 aluminum spun fan inlet funnel, and a 10 gauge G90 Galvanized steel motor support plate rail and structure.

2. The fan array shall consist of multiple fan and motor ”cubes” or “cells”, spaced in the air way tunnel to provide a uniform air flow and velocity profile across the entire tunnel cross section. Each fan shall rest in an identically sized cube or cell, spaced such that the array dimensions fill a minimum of 90% of the cross sectional area of the air way tunnel. There shall be no blank off plates or “spacers” between adjacent fan columns or rows to position the fans across the air way tunnel. Submittals for units providing less than the scheduled quantity of fans and/or spacing of the fans for multiple fan arrays shall submit CFD modeling of the air flow profile for pre-bid approval that indicates uniform velocity and flow across all internal components without increasing the length of the AHU unit or changing the aspect ratio of the unit casing as designed.
3. Each individual cube or cell in the multiple fan arrays shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan or multiple fans become disabled. The system effects for the back flow prevention devices shall be included in the criteria for TSP determination for fan selection purposes, and shall be indicated as a separate line item SP loss in the submittals. Back Draft Damper performance data that is per AMCA ducted inlet and discharge arrangements will not be accepted. Damper data must be for the specific purpose of preventing back flow in any disabled fan cube and that is mounted directly at the inlet of each fan. Motorized dampers for this purpose are not acceptable. AHU Manufacturers that do not manufacture the fans being submitted must provide certified performance data for fans as installed in the AHU unit with back draft damper effects included.
    a. The backdraft damper must allow for the re-start of a de-activated fan while the unit is running without back-spinning the fan and causing a VFD fault. If backdraft damper cannot achieve a running start through pressure differential, AHU manufacturer must provide a control methodology to allow for a VFD motor start while the rest of the fan array is running at max airflow allowable per system design.
4. Provide fan safety screen on discharge of each fan motor.
5. Each fan & motor assembly shall be removable through a 24” wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor. All fan/motor access doors shall open against pressure.
6. Airflow Monitoring System:
    a. Each fan shall be equipped with air flow monitoring probes with flow measuring transducer, providing +/- 2% accuracy. Airflow monitoring equipment shall be factory mounted on each fan cube. Pressure tubing for transducer shall be installed at the factory.
    b. Controls contractor shall connect BAS to the factory mounted transducer and program an algorithm to measure total airflow by summing the output from each transducer.

B. Motors
1. Each fan/motor cube or cell shall include a minimum 10 gauge, G 90 Galvanized steel intake wall, .100 aluminum spun fan inlet funnel, and a 10 gauge G90 Galvanized steel motor support plate rail and structure.
2. All motors shall be standard, foot mounted type TEAO selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be manufactured for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD. Motor HP shall not exceed the scheduled HP as indicated in the air handling equipment schedules. Steel cased motors and/or ODP motors are not acceptable.

3. All motors shall include permanently sealed (L10-400,000 hr) bearings and AEGIS™ shaft grounding to protect the motor bearings from electrical discharge machining due to stray shaft currents.
4. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, exceeding category BV-5, to meet or exceed an equivalent Grade G.55.
5. Fan and motor assemblies submitted for approval incorporating larger than 22” wheel size and 215 T frames size motors shall be balanced in three orthogonal planes to demonstrate compliance with the G.55 requirement. Copies of the certified balancing reports shall be provided with the unit O&M manuals at the time of shipment.
6. Each fan motor shall be individually wired to a dedicated circuit breaker and VFD equal to ABB model ACS320. All VFDs shall be contained within a single panel, factory mounted and wired on the air handling unit.
7. All motors in the fan wall array shall be provided with individual thermal overload protection.

C. Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

D. Flexible Connection: Install flexible duct connector at all inlet and outlet connections of the unit.

2.4 COILS

A. Casing with access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

B. Drain Pans: IAQ style drain pans shall be provided under all cooling coils. Drain pans shall be fabricated from 16 gauge 304 stainless steel. All pans are to be triple pitched for complete drainage with no standing water in the unit, and shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4” MPT drain connection extended to the exterior of the unit base rail. Units in excess of 159 inches shall have drain connections on both sides. All drain connections shall be piped and trapped separately for proper drainage. Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a copper downspout.

C. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.

D. Fabrication:
1. Tubes: 5/8 inch OD, .020” thick seamless copper expanded into fins, brazed joints, with .028” thick return bends.
2. Fins: .008” thick aluminum.
3. Casing: Die formed channel frame of galvanized steel. Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit.

E. Water Coils:
1. Headers: Seamless copper with die formed tube holes.
2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.

3. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/8" vent and drain provided on coil header for coil drainage. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 250 PSIG working pressure. Intermediate tube supports shall be supplied on coils over 44" fin length with an additional support every 42" multiple thereafter.

## 2.5 HUMIDIFIER

A. Humidifiers: Capacities and selection in accordance with ARI 610.

B. Steam Grid Humidifier: Stainless steel distribution tube with evenly spaced orifices extended full width of unit, factory mounted in plenum with drain pan for draw-through units. The humidifier capacity shall meet or exceed the capacity specified in the mechanical schedule. The size and number of distribution manifolds shall be sized so all steam is absorbed by the air before reaching the next component in the air stream. Humidifier shall receive steam at supply pressure and discharge at atmospheric pressure. Humidifier shall be furnished with inlet strainer and float and thermostatic traps or a bucket steam trap. Separating chambers shall be of a volume and design that will disengage and remove water droplets and particle matter when the humidifier is operating. The distribution manifold shall provide uniform distribution over its entire length and be jacketed by steam to assure that vapor discharged is free of water droplets. Provide 304 stainless steel liner in humidifier section.

## 2.6 FILTERS

A. Filter Box: Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by BLC, FARR or equal. Filter racks over 72" in length shall require an angle center reinforcement support. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters.

B. Filter Media: Refer to other division 23 specifications for filter media requriements.

C. Filter Gauges: 3-1/2 inch diameter diaphragm actuated dial in metal case, with static pressure tips. Filter gauge to have integral adjustable pressure switch for tie into BAS.

## 2.7 DAMPERS

A. Dampers: Provide Class 1 rated, ultra-low leak dampers as indicated on the unit drawings. Low leakage dampers shall have extruded aluminum airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate santoprene rubber edge seals and zinc plated or stainless steel tubular steel shaft for a non-slip operation. Shaft bearings shall be spherical – non corrosive nylon to eliminate friction and any metal to metal contact. Damper jamb seals shall be UV rated, nylon glass reinforced or stainless steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16 gauge galvanized steel frame.

B. Damper Leakage: Maximum 3.0 cfm per square foot at 1.0 inches wg pressure differential.

C. Damper Actuators: The Building Automation System contractor shall furnish electric damper actuators for outside air and return air dampers.

## 2.8 ELECTRICAL CHARACTERISTICS

A. The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number and current and amps voltage. The unit must have an ETL or UL Listing and bear the appropriate mark.

B. Conduit shall consist of a combination of EMT or flexible metal conduit as required. Liquidtite flexible metal conduit may be used outside the air tunnel for wet locations.

C. Unit Convenience Features:
1. Each section shall be equipped with a vapor- proof 100 watt service light with guard.
2. Lights shall be controlled by one light switch mounted adjacent to the supply air fan access door.
3. Furnish a 120 volt GFI duplex convenience outlet on the exterior of the unit.
4. All lights, switches and outlets shall be wired to a factory mounted transformer. Electrical contractor shall provide a single point power connection to the unit for power to lights and fan motors. A separate 120 volt power connection by electrical contractor shall not be required.

## 2.9 AIR HANDLING UNITS (OUTDOOR)

A. Manufacturers:
1. York/Johnson Controls.
2. Temtrol.
3. Daikin
4. Substitutions: Per section 23 00 00 – General mechanical Requirements.

B. Configuration: Fan section plus accessories, including:
1. Filter section.
2. Cooling coil.
3. Reheating coil.

C. Fabrication: Conform to AMCA 99.

D. Unit shall be provided completely assembled, or shipped in multiple sections and engineered for ease of field assembly. Field assembly shall be accomplished using factory provide gasket and bolts and not caulk. Each section shall include a permanent label to aid in proper field assembly. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

E. Provide unit with tags or decals to aid in service or indicate caution areas.

F. Rigging Provisions for Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

2.10 AHU CASING

A. Unit is specifically designed for outdoor applications.

B. Unit casing will consist of a structural frame with insulated roof, wall, and floor panels.

C. Removal of wall panels will not affect structural integrity of units.

D. Unit casing will be insulated with spray injected foam to achieve thermal resistance of R13 hr-ft2-°F/BTU. Insulation application will meet the requirements of NFPA 90A.

E. Unit will conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections..

F. Wall panels and access doors will deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.

G. Unit will have double wall, 2" insulated panels for walls, roof, and floor. Exterior skin will be galvanized and painted sheet steel. Individual segments will have galvanized sheet steel, stainless sheet steel, or perforated galvanized interior liner, as described in performance specifications.
   1. Panels with optional perforated liner (patent pending) will have 1" of 3 lb/ft.3 fiberglass board insulation, faced to prevent fiber erosion, and 1" of foam insulation. Exterior skin will be galvanized and painted sheet steel. Interior liner will be perforated galvanized. Minimum perforated panel thermal resistance will be R11 hr-ft2-°F/BTU.

H. Unit roof will be double-sloped with a longitudinal peak and a minimum pitch of 1/4" per foot.
   1. Roof snow-loads capacity will be at least 50 lb/ft2.
   2. Roof overhangs unit perimeter by 1-1/2".

I. Floor panels will be double wall construction, designed to provide at most L/240 deflection when subjected to a 300 lb. load at mid-span.

J. Double wall access doors will be provided on sections as shown on product drawings.
   1. Stainless steel hinges permit a 180° door swing.
   2. Access door will be of the same material type as exterior/interior casing.
   3. Access door latches will use a roller cam latching mechanism.

K. View ports will be double-pane tempered glass.

L. Primary and auxiliary drain pans will comply with the guidelines of ASHRAE 62.
   1. Drain pans will be double sloped at least 1/8" per foot, and have no horizontal surfaces.
   2. Drain connection material will be the same as drain pan.
   3. Drain pans will drain to one point.
   4. Drain connections will be welded to drain pans
   5. Drain pans will have at least 1" clearance between pan and coil supports.

## 2.11 AHU FANS

A. Fans will provide CFM and static pressure, as shown in performance specifications.

B. Fans will be Class II

C. Fans will be DWDI (housed)

D. Fans will have forward curved or airfoil blades, as shown in performance specifications.

E. Airfoil fans will bear the AMCA Seal. Airfoil fan performance will be based on tests in accordance with AMCA standard 210 and will comply with the requirements of AMCA certified ratings programs for air and sound. Airfoil wheels will comply with AMCA standards 99-2408-69 and 99-2401-82.

F. Fans shafts will be polished steel and sized such that the first critical speed will be at least 125% of the maximum operating speed for the fan pressure class. Shaft will be coated with an anti-corrosion coating.

G. Fan and motor assembly will be internally mounted on a common base. Fan and motor base will be spring isolated on a full width isolator support channel.
   1. Fan motor will be on an adjustable base.
   2. Fan discharge will be connected to cabinet via a flexible connection.
   3. Access doors will be provided as shown on product drawing.

H. Fans will have a sharply rising pressure characteristic extending through the operating range and continuing to rise beyond the peak efficiency to ensure quiet and stable operation. Fans will have a non-overloading design with self-limiting horsepower characteristics and will reach a peak in the normal selection area.
   1. Performance — Fans will be tested in accordance with AMCA 210 and AMCA 300 test standards for air moving devices and will be guaranteed by the manufacturer to deliver rated published performance levels.
   2. Construction — Fans will be designed without a scroll type housing and will incorporate a non-overloading type backward inclined airfoil blade wheel, heavy-gauge reinforced steel inlet plate and structural steel frame.
   3. Frame and Inlet Panel — Inlet panels will be of heavy-gauge reinforced steel construction. The inlet panel incorporates a removable spun inlet cone designed for smooth airflow into the accompanying inlet retaining ring of the fan wheel. A square, formed lip suitable for attachment of a boot connector will surround the unit.
   4. Wheel — Wheels will have a spun non-tapered style blade retaining ring on the inlet side to allow higher efficiencies over the performance range of the fan. Wheels will have airfoil-shaped extruded aluminum blades. All hollow blade wheels will be continuously welded around all edges. Wheels will have twelve blades for better sound quality. All wheels will be statically and dynamically balanced per ANSI/AMCA 204.
   5. Finish and Coating — The entire fan assembly will be thoroughly degreased and deburred before application of a rust-preventative coating. Aluminum components will be unpainted.
   6. Motors — Provide TEFC Premium Eff. with Aegis Shaft Grounding factory installed. Motor frames will be cast iron – rolled steel frames are not acceptable

7. Fan Balancing — All fans prior to shipment will be individually balanced. Maximum vibration will be within the limits of ANSI/AMCA 204 Fan Application Category BV-4 BV-5. Balance readings will be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings.
8. Vibration Isolation — Fans will not require spring isolators in order to meet the ANSI/AMCA 204 Fan Application Category BV-4 BV-5 rating.
9. Factory Run Test — All fans prior to shipment will be completely assembled and test run as a unit at the specified operating speed or maximum RPM allowed for the particular construction type. Maximum vibration will be within the limits of ANSI/AMCA 204 Fan Application Category BV-4 (optionally BV-5). Balance readings will be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings.
10. Fan Options — The following options will be available for multiple fans:
    a. Piezometer Ring: Airflow station will be factory installed in each fan inlet. Tubing will be manifolded so that the measurement is representative of all fans in the array. The device will have a measurement accuracy of ± 5%.

I. Fan bearings will have average life (L50) of at least 200,000 hours. Bearing fatigue life ratings will comply with ANSI/AFBMA 9.

J. DWDI fans will be belt-driven. SWSI fans will be belt driven or direct driven, as shown on product drawings.

K. Forward curved fans smaller than 18” will have permanently lubricated bearings. Re-greaseable fan bearings will be factory lubricated and equipped with standard hydraulic grease fittings.

L. Fan drives will be selected for a 1.5 service factor and will be furnished with anti-static belts.
1. Drives 20 hp or larger or drives on fans with VFDs will be fixed pitch.
2. Sheaves will be machined from close grain cast iron and statically balanced.
3. Drive belts will be V type, precision molded, raw edge construction, anti-static, oil and heat resistant.

## 2.12 AHU COILS

A. Coil connections 2” and less to have copper connections.

B. Water, direct expansion (DX), and steam coil capacity and pressure drop performance will be certified in accordance with AHRI Standard 410, when selected within fluid velocity, inlet fluid temperature, and entering air temperature ranges specified by AHRI 410.

C. Cooling coil segments will have a full-width IAQ drain pan that extends at least 6” downstream of the last coil in the section.

D. Coils will be removable from the side of unit, via removable AHU panels. No more than one panel must be removed to remove a coil.

E. Coils will have frames constructed of galvanized steel. Casing channels will be free-draining and do not block fin area.

F. Cooling coils with finned height greater than 48” will have an intermediate drain pan with downspout to drain condensate to main drain pan. Intermediate drain pan material will match coil frame material.

G. Coil segment door clearances will allow for at least 2-inches of field installed piping insulation.

H. Coil bulkheads and blank-offs will prevent air from bypassing coils.

I. Coil segment casing to accommodate full-face or reduced-face coils will be provided. Provide face and bypass coil segments with factory installed bypass damper

J. Coil connections will be extended through unit casing.

K. Water and glycol coils will have a 1/4" FPT plugged vent or drain tap on each connection that is accessible from outside the unit.

L. Spool shaped coil grommets will be provided to insulate and seal coil penetrations.

M. Water and glycol coils will be designed to operate at 250 psig and up to 300° F and will be factory tested with 325 psig compressed air under water.

N. Water, glycol and DX coils tubes will be mandrel expanded to form fin bond and burnished, work-hardened interior surface.

O. Fabrication:
1. Tubes: 1/2 inch OD, .016” thick seamless copper expanded into fins, and brazed joints.
2. Fins: .008” thick aluminum.
3. Casing: Die formed channel frame of galvanized steel. Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit.

## 2.13 AHU FILTERS

A. Filter segments will be provided, as shown on product drawings. Filter tracks/frames will be an integral part of the unit.

B. Filter media for Solution units delivered in the continental United States will not be shipped with units. Filters will be shipped to a customer defined location. Coordinate filter delivery with Johnson Controls sales representatives.

C. Filter types, nominal sizes, efficiencies, and performance characteristics will be as shown in performance specifications.

D. Filter access will be provided via access doors on filter segments or adjacent segments as required by filter loading scheme.

E. Flush mounted, factory installed differential pressure gauge on the drive side of unit to measure pressure drop across filters will be provided

F. Filter Gauges: 3-1/2 inch diameter diaphragm actuated dial in metal case, with static pressure tips. Filter gauge to have integral adjustable pressure switch for tie into BAS.

2.14 AHU DAMPERS

A. Dampers will be factory installed.

B. Dampers will have airfoil blades with extruded vinyl edge seals and flexible metal compressible jamb seals.

C. Dampers will have a maximum leakage rate of 4 CFM/square foot at 1" w.g. and comply with ASHRAE 90.1.

D. Maximum damper torque requirement will be 7 in. lbs./ft2.

E. Damper blades will be parallel acting unless submitted otherwise.

F. Damper blades will be galvanized steel or aluminum.

G. Damper Actuators: The Building Automation System contractor shall furnish electric damper actuators for outside air and return air dampers.

2.15 AHU ELECTRICAL CHARACTERISTICS

A. The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number and current and amps voltage. The unit must have an ETL or UL Listing and bear the appropriate mark.

B. Conduit shall consist of a combination of EMT or flexible metal conduit as required. Liquidtite flexible metal conduit may be used outside the air tunnel for wet locations.

C. Unit Convenience Features:
5. Each section shall be equipped with a vapor- proof 100 watt service light with guard.
6. Lights shall be controlled by one light switch mounted adjacent to the supply air fan access door.
7. Furnish a 120 volt GFI duplex convenience outlet on the exterior of the unit.
8. All lights, switches and outlets shall be wired to a factory mounted transformer. Electrical contractor shall provide a single point power connection to the unit for power to lights and fan motors. A separate 120 volt power connection by electrical contractor shall not be required.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with ARI 430.

B. Install flexible connections between unit and inlet and discharge ductwork. Install metal bands of connectors parallel with minimum 1 inch flex between ductwork and fan while running.

C. Install floor mounted units on concrete housekeeping pads at least 4 inches wider than unit. Coordinate pad height with condensate trap requirements.

D. Install condensate piping with trap and route from drain pan to location designated on Drawings.

3.2 INSTALLATION CHILLED WATER COILS

A. Make connections to coils with unions or flanges.

B. Connect water supply to leaving airside of coil (counter flow arrangement).

C. Locate water supply at bottom of supply header and return water connection at top.

D. Install water coils to allow draining and install drain connection at low points.

E. Install valves and piping specialties in accordance with details as indicated on Drawings.

F. Install manual air vents at high points complete with shutoff valve.

3.3 MANUFACTURER'S FIELD SERVICES

A. Factory technician shall perform startup service. Factory startup reports shall be included in close out document packet.

3.4 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.5 DEMONSTRATION

A. Demonstrate unit operation and maintenance.

B. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days' notice to Engineer of training date.

3.6 PROTECTION OF FINISHED WORK

A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

**END OF SECTION**

# SECTION 238219 - FAN COIL UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Ductless fan coil units and accessories.
   2. Ducted fan coil units and accessories.

### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

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 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
   1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

### 1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.7 WARRANTY

A. Warranty: Provide manufacturer's standard warranty.

**PART 2 - PRODUCTS**

2.1 SYSTEM DESCRIPTION

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

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTLESS FAN COIL UNITS

A. Fan Coil Unit Configurations: Row split

B. Coil Section Insulation: 1-inch thick, coated glass fiber or foil-covered, closed-cell foam complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
   1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
   2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Drain Pans: Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1.

D. Chassis: Galvanized steel where exposed to moisture with baked-enamel or powder-coat finish and removable access panel. Floor-mounting units shall have leveling screws.

E. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
   1. Vertical Unit Front Panels: Removable, steel, with discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
   2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with discharge grilles.

F. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
   1. MERV Rating: As scheduled on the Drawings when tested according to ASHRAE 52.2.

G. Hydronic Coils: Copper tube with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

H. Fan and Motor Board: Removable.
1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

I. Factory, Hydronic Piping Package: ASTM B88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
1. Two-way, two-position control valve for dual-temperature coil.
2. Two-way, two-position or modulating control valves as indicated on the plans.
3.
4. Hose Kits: Minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
   a. Length: 24 inches .
   b. Minimum Diameter: Equal to fan coil unit connection size.
5. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
6. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
7. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
8. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
9. Wrought-Copper Unions: ASME B16.22.
10. Risers: ASTM B88, Type L copper pipe with hose and ball valve for system flushing.

J. Control devices and operational sequences, as shown on drawings. Electrical Connection: Factory wire motors for a single electrical connection.

K. Capacities and Characteristics:
1. Unit configuration, capacities, and characteristics are scheduled on the Drawings.

## 2.3 DUCTED FAN COIL UNITS

A. Fan Coil Unit Configurations: Row split.
1. Number of Cooling Coils: As scheduled on the Drawings.

B. Coil Section Insulation: 1-inch- thick, coated or foil-faced glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
   1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.

C. Drain Pans: Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1.

D. Chassis: Galvanized steel where exposed to moisture, with baked-enamel or powder-coated finish and removable access panel. Floor-mounting units shall have leveling screws.

E. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
   1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis with mill-finish, aluminum, double-deflection grille.
   2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
   3. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
   4. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

F. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.

G. MERV Rating: As scheduled on the Drawings when tested according to ASHRAE 52.2.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

I. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

J. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

K. Factory, Hydronic Piping Package: ASTM B88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
   1. Two-way, two-position control valve for chilled-water coil.
   2. Two-way, modulating control valve for heating coil.
   3. Hose Kits: Minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
      a. Length: 24 inches .
      b. Minimum Diameter: Equal to fan coil unit connection size.
   4. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
   5. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi,

connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.

6. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
7. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
8. Wrought-Copper Unions: ASME B16.22.

L. Control devices and operational sequence are specified on the drawings.

M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

N. Capacities and Characteristics:
1. Unit configuration, capacities, and characteristics are scheduled on the Drawings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

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

### 3.2 INSTALLATION

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Suspend fan coil units from structure with elastomeric hangers.

D. Install new filters in each fan coil unit within two weeks after Substantial Completion.

### 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
1. Install piping adjacent to machine to allow service and maintenance.

2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.
   a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors. Comply with safety requirements in UL 1995 for duct connections.

## 3.4 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. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

## 3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

**END OF SECTION**

# SECTION 25 10 00 - INTEGRATED AUTOMATION NETWORK EQUIPMENT

## PART 1 - GENERAL

### 1.1 OVERVIEW

A. This Section describes the desired elements for development of the BACNET Protocol Building Automation System (BAS) at New Mexico State University.

B. At the building level, the BAS system architecture utilizes intelligent distributed control modules located in each building which communicate using BACnet/IP (preferred) over Ethernet or BACnet MS/TP over EIA-485 Local Building Automation Networks. A given building commonly contains several such Local Building Automation Networks. A typical single network might serve all the terminal units on a single floor of the building. Another typical network might serve the various pumps, valves, VFDs, etc., making up the central mechanical system of a building.

C. The Local Building Automation Networks communicate with each other and NMSU central monitoring and control system primarily through NMSU- provided Tridium Niagara AX Network Area Controllers (NAC) on NMSU Building Automation Network. These are BACnet Building Controller (B-BC) devices which provide standard BACnet router and BBMD functions as well as BACnet/IP and MS/TP (master) connectivity. They also provide connectivity to the NMSU central monitoring and control system. (The PICS information for these devices is available upon request to FS Operations). All Local Building Automation Networks must be designed, configured, and installed for successful operation in this environment. The Local Building Automation networks are private networks internal to NMSU and are not accessible for remote connections. All activities which require network connections (including but not limited to commissioning or maintenance) must be accomplished by the use of direct on-site physical connections. Any contractor or vendor equipment to be used on these networks must be registered in advance with FS Operations.

D. All NMSU user interface and Operator Workstation capabilities are provided by NMSU as part of its central monitoring and control system.

E. The equipment connected on each Local Building Automation Network shall be designed, configured, and installed so as to maintain stable and safe operation of the equipment in the event of any failure of network communication with any other Local Building Automation Network or NMSU central system. If it is necessary that data be exchanged between equipment on different Local Building Automation Networks, even while normal network connections through the controls contractor BAS Network Area Controller (NAC) are disrupted, then such interconnections shall be accomplished using hard-wired I/O points.

F. All installed equipment must be fully compliant with ANSI/ASHRAE Standard 135-2004 (BACnet) and all published addenda at the time of installation. No protocol gateways, non-compliant or proprietary equipment, or communication techniques of any kind are to be used on the Local Building Automation Networks without prior approval from FS Energy Management shop.

1.2 RELATED DIVISIONS AND SECTIONS

A. See Division 25 30 00 for field devices.

B. Other related divisions and sections as applicable to the project as determined by the Design Firm. Additional references should include electrical, test and balance, submittal requirements, valves, sheet metal products, and commissioning, as applicable.

1.3 SCOPE

A. It is the intent of this Section to describe elements necessary to provide, install, connect, program, and calibrate the additions and/or modifications to the BAS as necessary to provide fully automatic control for all systems as shown in the Control Drawings, stated in the sequences of operation, indicated in the electrical ladder diagrams, or as otherwise required by the Contract Documents. Some equipment controls are specified to be provided in other portions of the Contract Documents, including NMSU-furnished equipment. Work related to this Section must be coordinated by the Contractor with other suppliers and trades to provide a complete and fully functional BAS.

B. Appropriate engineering, installation supervision, programming, calibration, startup, test and balance, and checkout necessary for a complete and fully operational BAS, shall be provided as part of the work scope by the Contractor with no dependency on NMSU Niagara system. Any request for Niagara component dependency must have prior approval from FS Energy Management.

1.4 SUPPLIER AND EQUIPMENT REQUIREMENTS

BAS Supplier will be the authorized factory representative or branch office of the product manufacturer proposed. All software and hardware products shall be BACnet compatible to the level specified.

NMSU Approved Brand Name Equipment (to be) Specified:

Automated Control Systems (Alerton) – Albuquerque, NM
Control and Equipment Co. (Schneider Invensys) El Paso, TX PC Automated Controls (Automated Logic)- El Paso, TX Trane (Trane) – El Paso, TX

Energy Control Inc. (Delta) – Las Cruces, NM
GEW Mechanical (Reliable)- Albuquerque, NM
NSW Controls (Reliable) – Albuquerque, NM
Johnson Controls (Johnson Controls) – Albuquerque, NM
ThermAir (Distech) Mesa, AZ

1.5 SUBMITTALS

A. One set of electronic Shop Drawings and Submittal Data shall be submitted in accordance with the General Contract Requirements. These are usually submitted within 30 days of Contract award.

B. Submittals shall consist of Shop Drawings, Catalog Data Sheets, Graphic Displays, and Software Development parameters as defined in the following paragraphs. No materials shall be purchased, and no work shall be conducted at the job site until submittals have been reviewed and approved by FS Operations.

1. Shop Drawings shall be provided which show detailed communications architectures (including the existing communication network), control devices, electrical ladder diagrams, control system schematics, Protocol Implementation Conformance Statements (PICS), sequences of operation, point lists, and a material list. All systems and the associated control components as well as all connections between components shall be clearly indicated. The submittal shall indicate the required coordination with all other equipment. The intent is for Shop Drawings to be comprehensive enough for the installation crew to complete all aspects of the installation without the need for supporting documentation, except third-party equipment installation manuals. All wiring shown on the Drawings shall be labeled on both ends and these labels shall be used in the installation process for ease of comparing the Shop Drawings to the actual field installation. Each control component shall be given a unique identifier. This identifier shall be used in creating equipment field device labels and in the Sequence of Operation so that reference to the Drawings can be easily made.

   a. Electrical Ladder Diagrams shall be shown on the Shop Drawings. Electrical Ladder Diagrams shall show the specific details of all switches, relays, motor starters, etc. The Electrical Ladder Diagrams shall show the correct control wiring and interlock wiring of all equipment provided under the Contract. Each diagram shall reference the correct power source by breaker panel and circuit number.

   b. The Sequence of Operation for each controlled system shall be provided with reference to the actual control device identifiers. The Sequence of Operation shall break down the control operation by function (e.g., mixed air control, occupied/unoccupied, smoke purge, etc.) and describe in detail the correct operation and interaction with other system functions.

   c. A complete Material List shall be included on the Shop Drawings which show the device model numbers, control device identifiers, quantities, manufacturers, etc., of all equipment provided under this Section. The Material List shall be organized in alphabetical order so that it can be easily compared to the associated Catalog Data Sheets.

2. Catalog Data Sheets will be provided for each different piece of equipment

provided. At a minimum, the Data Sheet shall contain sufficient information so that compliance with the design intent can be verified. Where multiple models or options are indicated on the same Catalog Data Sheet, the equipment proposed shall be highlighted or otherwise indicated. The Catalog Data Sheets shall be organized in alphabetical order to match the Material List on the Shop Drawings.

3. Point Verification forms shall be submitted for all points that will be installed as part of the BAS. Once approved, the Contractor shall complete the forms during startup to document successful point functionality. The completed forms shall be included as part of the record documentation. NMSU reserves the right to designate a representative to monitor completion of the Point Verification.

4. An Interface Specification shall be submitted as a Microsoft Excel spreadsheet describing each Local Building Automation Network including its BACnet network number, the complete list of devices to be placed on each such network, the BACnet Device Object instance number for each device, the BACnet object names and identifiers to be used within each device including identification of those objects for which commissioning trend logs will be provided, the MAC addresses of MS/TP devices, and all BACnet object cross-references between the devices on the complete set of Local Building Automation Networks (a sample spreadsheet in the required format can be obtained from NMSU Project Representative ). The BACnet network numbers and Device Object instance numbers must be selected from ranges requested by the Contractor from NMSU Project Representative. The object names must have a <facility>.<system>.<point> structure such as “WELLS.AHU_1.CWS_TEMP”. The Interface Specification must be accompanied by a Microsoft Word or Adobe PDF document presenting the Protocol Implementation Conformance Statements (PICS) for all devices to be provided. No automation devices are to be installed prior to approval of the Interface Specification’s complete contents by NMSU Project Representative. The Interface Specification must include the MAC address for each Ethernet device. NMSU Project Representative will then provide the IP address to be used by each of these devices.

5. All Graphic Slides proposed for use shall be submitted to NMSU Project Representative for review and approval. The submitted slides shall be printed in color. All real-time display fields, user input fields, etc., shall be clearly indicated.

6. Software Development parameters including all trend logs, reports, point alarm parameters, passwords, and scheduling shall be submitted as described here. The information contained in the submittal will be followed during development of the programming code and shall be used for evaluation of the system's performance during the commissioning phase by utilizing the controls contractor design computer application.

    a. Report templates shall indicate what information will be presented

on each report, how the information will be presented, report hard disk upload parameters, and report log file names.

b. NMSU FS Energy Management personnel shall have user accounts within the contractor's design engineering application for purpose of reviewing point names, equipment sequences, graphics, and network architecture.

c. NMSU will provide blank schedule forms for each air handling unit for completion and submittal by the contractor for review and acceptance by FS Energy Management. Additionally, FS Energy Management will identify schedule groups of HVAC equipment.

7. The controls contractor will provide personnel names, phone numbers, e-mail addresses, job descriptions, , mobile phone numbers, etc., will be provided for position titled project manager, project engineer, project programmer(s), installation foreman, and any other individuals key to the completion of this project. If at any time during the project the assignment of personnel changes, NMSU shall be notified and the previously listed information will be updated for the newly assigned individuals.

## 1.6 RECORD DRAWINGS

A. Record Drawings shall be provided as required by the general Contract Requirements. Record Drawings will be started and updated throughout the construction period and completed upon the contract's substantial completion date. Any changes made during installation shall be recorded on the Contractor's master record drawings as the changes are made so that a current Record Drawing is constantly being updated. These As-built Drawings shall be available at all times for inspection by NMSU, or NMSU Project Representative.

B. The Contractor shall furnish a complete spare parts lists, operating instructions, maintenance literature, and completed point verification forms.

C. At completion of the Project, all hand-drawn field changes shall be incorporated into an AutoCAD version of As-built Drawings.

D. Non-drawing project data shall be provided electronically as Microsoft Office documents. These As- built Drawings shall be used during the training sessions.

E. Upon final occupancy, the Contractor will deliver to NMSU all project-specific design control software programs in a usable electronic format acceptable to NMSU. The contractor will deliver a final set of all project-specific design control software programs reflecting all updated and final settings. NMSU will use this control software to program, configure, install, commission, expand, or maintain any element or aspect of the installed system. All software packages must be permanently licensed in the name of NMSU and include full no-added-charge support by the manufacturer for the duration of the project warranty period.

## 1.7 EQUIPMENT START-UP

A. During the initial startup phase of the project, the BAS Supplier shall permit NMSU's operating personnel to be involved with the troubleshooting, initial startup, point verification testing, and performance trending

1.8 SYSTEM TESTING

A. At the termination of the point verification process, the Contractor shall submit completed and approved Point Verification as-built forms for each point.

B. Upon successful completion of all Point Verification testing, the Contractor shall submit hard copies of the Trend Logs called out in the approved Interface Specification (see section 1.5. B. 4.). The Trend Logs shall trend at least 48 hours of normal uninterrupted operation (non-weekend or holiday) for the purpose of documenting proper implementation of the control sequences of operation.

C. NMSU reserves the right to participate in, or assign a representative to participate in, the startup, testing, programming, or any other aspect of the construction of this project. Contractor to provide notice of any or all phases listed above to the NMSU Project Representative no less than fourteen calendar days prior to the event.

1.9 TRAINING

A. Required training shall be provided by the Contractor as specified in the Contract documents. The duration of each phase of training shall be appropriate for the scope of the project.

B. Prior to the final system trending, the Contractor shall provide training for NMSU-designated operating personnel. The training shall cover all general aspects of the BAS system installation, wiring, calibration techniques, programming, troubleshooting, etc. The training shall provide the same structure and depth as that provided to factory-authorized representative's installation and programming personnel. This training shall be conducted on site and shall focus on the specifics of the project. A complete training booklet shall be provided and used during the training period. The booklet shall include the As-built Drawings.

C. The BAS Supplier shall provide additional on-site training during the warranty period, at no additional cost to NMSU The Contractor shall provide this training at the request of the NMSU. NMSU will give at least one-week notice of the need for additional training. Warranty and service time shall not constitute training hours.

1.10 SERVICE AND WARRANTY

A. The system supplier shall maintain a maintenance support facility complete with system technicians, diagnostic and test equipment. Emergency service shall be available in the local office on a 24-hour, 7-day a week basis. The service agent shall provide a continuously monitored local service telephone number for emergency service.

B. If the manufacturer's material, equipment, or hardware has a standard warranty that exceeds the specified requirement then the longer manufacturer's warranty shall be provided. Warranty shall be for all materials and labor provided as the Scope of Work of this Section.

C. During the warranty period, include 24-hour-per-day, 7-day-per-week, call back service for any situation as defined by the NMSU Project Representative. Callback service will require a response time of 48 hours.

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. All products shall be selected in accordance with Part 2 of this Section. Installation of the components shall be in accordance with Part 3 of this Section.

B. Also see section 25 30 00 for field devices.

### 2.2 NETWORKING/COMMUNICATIONS

A. Campus Networks

1. NMSU's Building Automation Network shall be used for access to the Local Building Automation Networks and the NMSU central monitoring and control system.

2. The Building Automation Network and the Campus Local Area Network shall be extended as required by the Contract drawings and specifications.

B. Local Building Automation Networks

1. All BACnet controllers shall reside on a Local Building Automation Network. NMSU's Network Area Controllers are used for monitoring and interacting with the Local Building Automation Networks, and between the Local Building Automation Networks and the NMSU central monitoring and control system.

2. All devices that reside on a Local Building Automation Network shall communicate in native BACnet. Proprietary protocols will not be permitted.

3. NMSU's preference is that no more than 35 BACnet devices shall be placed on a single Local Building Automation Network. Approval will not be given for more than 60 BACnet devices on a single Local Building Automation Network.

### 2.3 BACnet COMPATIBILITY

A. All controller devices supplied to meet the functional and operational requirements shall conform, at a minimum, to one of the BACnet device profiles contained in BACnet, Annex L:

1. BACnet Building Controller (B-BC), or

2. BACnet Advanced Application Controller (B-AAC) or

3. BACnet Application Specific Controller (B-ASC).

B. The interoperability requirements of such devices are contained in Annex L of the BACnet standard. B-BC controller devices shall communicate using BACnet/IP. BACnet/IP is also preferred for other devices, but BACnet over MS/TP at 78.4 Kbps is acceptable. ARCNET at 156 Kbps is acceptable but only when accessed via a BACnet/IP router. No other protocols or techniques are acceptable.

2.4 INPUT/OUTPUT AND INTERLOCK WIRING

A. Class I Circuits

1. All materials required for installation of Class I circuits or circuits operating at greater than 48 VAC or VDC shall meet the requirements stated in Division 26, National Electric Code, and all applicable building codes as they apply to Class I circuits.

B. Class II Circuits

1. All materials required for installation of Class II circuits shall meet all requirements of the National Electric Code and all applicable building codes as they apply to Class II circuits.

2. All cables shall be run in dedicated conduit no smaller than ¾" or a metallic raceway and shall contain conductors per the manufacturer's recommendation for the application. The number of conductors shall be as required by the application and an overall foil shield with stranded drain wire shall be provided in all cases. The cable shall be factory stamped with a clear indication of the cable classification. The cable jacket shall be PVC. Metallic raceway and conduit shall be as specified in Division 26.

3. Local Building Automation Network cables shall be in dedicated conduit containing no other signal or power wiring.

PART 3 - EXECUTION

3.1 GENERAL

A. All field hardware, control devices, conduit, wiring, etc., shall be provided as specified in Part 2 of this section and in section 25 30 00 Field Devices.

1. The installation of all aspects of the system shall comply with all applicable codes, regulations, and all related Contract Documents.

2. The installation of all materials shall be in accordance with the published manufacturer recommendations.

3. Where miscellaneous materials are required to complete an installation, i.e., isolation valves for pressure switches, wall switches for an exhaust fan control circuit, etc., the materials shall be supplied as defined in the relevant sections of these Guidelines.

4. Coordinate with other trades where installation of a particular component requires other trades to be involved. Installation coordination includes location of the correct placement of thermowells, flow switches, dampers, control valves, control power circuits, etc. Care must be exercised to identify locations that meet the requirements of the manufacturer including upstream and downstream distances, pressures, temperatures, etc.

5. All signal wiring requiring shielding shall have the shield terminated at the controller end only.

6. Label all wiring with permanent labels indicating the point device identifier. Install a phenolic label mounted at the device indicating the device type and point identifier name.

7. All field devices shall be labeled with 1" x 3" phenolic labels. Labels shall include the point name and device name. Labels for BAS controllers shall indicate the breaker and panel number of the power source. Labels shall be glued, attached with screws, or factory attached labels in the case of valves and actuators.

8. On each terminal unit and fan control unit, provide an adhesive label showing the unit identification of the device exactly as it appears on the construction drawings. The label shall be approximately three inches high by five inches wide, with the identification characters approximately one inch high. The characters shall be printed in black on an orange background. The label shall be placed on the unit at a location easily observable by maintenance personnel.

B. All software development shall be completed by BAS programmers that have been factory trained in programming and graphic development techniques of the BAS.

## 3.2 NETWORKING/COMMUNICATION

A. General

1. All LANs shall strictly be installed in a manner recommended by the manufacturer and in accordance with NMSU ICT network standards based on the environment, communications speed requirements, and distance. All LAN media shall be installed in a manner that provides protection from physical damage and interference from RF or other electrical sources. Campus Networks

B. Campus Networks

1. All media required to connect Operator Workstations or Network Area Controllers to NMSU's networks shall be installed with materials and procedures that comply with the requirements of NMSU ICT network standards and the BAS equipment manufacturer. [See Division 27].

C. Local Building Automation Networks

2. The Local Building Automation Networks shall be installed with materials and procedures in strict compliance with the requirements of the BAS equipment manufacturer.

3.3 BACnet COMPATIBILITY AND OBJECT REQUIREMENTS

A. All BAS software shall be developed in accordance with the approved PICS for the device. See Part 1 of this Section.

B. The Out of Service property shall be writable using BACnet services for all Analog, Binary, Multi-state, Loop, and Program objects.

C. All Analog (Input, Output, and Value), Loop, and Multi-state (Input, Output, and Value) objects shall have the capability of using the Change of Value reporting mechanism and the COV Increment shall be writable using BACnet services.

D. PID loops shall be represented by Loop objects, with writable tuning constant properties.

3.4 BAS CONTROLLERS

A. General

1. New controllers will be installed where required or indicated on the Drawings. However, in no case shall more than 90% of the maximum attached potential node limitations be designed, nor shall more than 75% of the controller RAM be utilized by the programming code specified herein, including trending, and global programming. If these limits are met, additional controllers or RAM must be added.

2. All controllers shall be installed in accordance with manufacturer's instructions. Electrical power shall be provided to each device at the appropriate voltage and frequency. All power shall be verified prior to powering the controllers.

3. All BAS controllers shall be installed in a NEMA rated enclosure appropriate to the environment in which it will be installed that provides protection from the environment and is adequately ventilated to protect against excessive temperature exposure. If located outdoors or in

mechanical rooms or similar harsh environments all penetrations of the enclosure shall be made through the bottom of the enclosure and not the top or sides.

B. Communications

1. All devices shall be installed and connected to Local Building Automation Network in a manner recommended by the manufacturer based on the environment, communications speed requirements, and distance.

C. Input/Output

1. All BAS field control components and the associated I/O wiring back to the respective controller will be installed and each point shall be checked by the Contractor for voltage, short circuit, etc., prior to termination to the controller to prevent any damage to the controller.

D. Software Requirements

1. All Sequences of Operation as stated in the Contract Documents are to be implemented.

E. Alarms

1. Alarms shall be provided as stated in the Contract Documents.

2. Alarms shall be suppressed when equipment has been intentionally forced to an inoperative status (e.g., night setbacks).

F. Minimum Runtimes

1. All digital output points shall have a minimum runtime as stated in the Contract Documents Sequence or Operations, otherwise as appropriate to the application, to prevent unintentional short cycling of the equipment.

G. Trend Analysis

1. The system shall be configured to trend those system points stated in the Contract Documents. Date and time stamps shall accompany all trend data. The initial interval for all trend logs shall be configured to be 15 minutes.

3.5 INPUT/OUTPUT AND INTERLOCK WIRING

A. See Part 2 of this Section.

3.6 EQUIPMENT CONNECTIONS

A. BAS Class II field wiring for all non-control device applications shall be installed by the Contractor. This includes equipment such as VFDs,

chillers, boilers, etc., which may have point types including status or alarm monitored from an equipment supplier Class C contact or analog control signals to equipment, etc.

- end of section -

# 25 30 00 - INTEGRATED AUTOMATION INSTRUMENTATION & TERMINAL DEVICES

## PART 1 - GENERAL

### 1.1 RELATED DIVISIONS AND SECTIONS

A. See Section 25 10 00 for environmental management system.

B. Other related divisions and sections as applicable to the project as determined by the Design Firm. Additional references should include electrical, test and balance, submittal requirements, valves, sheet metal products, and commissioning, as applicable.

### 1.2 SCOPE

It is the intent of this Section to describe the field devices necessary to provide fully automatic control for all systems as shown in the Control Drawings, stated in the sequences of operation, indicated in the electrical ladder diagrams, or as otherwise required by the Contract Documents. Some equipment controls are specified to be provided in other portions of the Contract Documents, including NMSU-furnished equipment. The Contractor shall coordinate with these other suppliers and trades to provide a complete and fully functional EMS.

### 1.3 SUBMITTALS

A. See Section 25 10 00.

### 1.4 RECORD DRAWINGS

A. See Section 25 10 00.

### 1.5 SYSTEM TESTING

A. See Section 25 10 00.

### 1.6 TRAINING

A. See Section 25 10 00.

### 1.7 SERVICE AND WARRANTY

A. See Section 25 10 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Preferred brand names:

1. Variable Frequency Drives (VFDs) shall be manufactured by ABB, or equal. The drives shall be located in the Electrical or Mechanical room close to the equipment. Equipment on VFDs that is identified as critical to maintain operational if the VFD fails shall have bypasses. This equipment is to be identified with the owner (NMSU F&S). Equipment with bypasses must me capable of full speed operation, i.e. if bypass is provided the ductwork must be designed for 100% of fan volume, so not to over pressurize the duct.

2. Steam Control Valves shall be manufactured by Siemens Building Technologies, Inc., or equal. Steam valve actuators must be rated to operate under high temperature conditions with a mean temperature operating range of approximately 250 deg F (Siemens SDK electro-hydraulic type actuator or approved equal).

1.2 FIELD DEVICES

A. All devices and equipment shall comply with all applicable local code requirements.

1. Temperature Sensors - with accuracy of + .5°F @ 77°F).

2. Humidity Sensors - Duct Sensor with accuracy of + 3% RH @ 77°F, range of 10% to 90% RH, including hysteresis, linearity, and repeatability. Room Sensor 5% RH @ 77°F, range of 0% to 100% RH.

3. Pressure Sensors – sized as needed for best accuracy.

4. Dampers- sized for specific application.

5. Damper Operators- sized for specific application.

6. Automatic Control Valves- sized for specific application (provide separate Valve Schedule). All valves must be installed with plastic engraved name tags to match Valve Schedule. Attach with stainless chain. Sequence staging shall be provided via the DDC system. Control valves over ½" shall be provided with a means to manually position the valve.
7. Low Temperature Detection Stat – Manual reset. Must be hard-wired to motor control center or VFD with a second contact for DDC alarm generation.

8. All field mounted valves- damper actuators, and sensors must have plastic engraved type nameplates attached by stainless braid or other permanent type attachment. ID tag shall identify the device as shown on submittal

drawings. Dymo type labels shall not be acceptable.

9. Field devices such as relays shall be located in each equipment's respective control panel. Wall mounted devices are not acceptable. All field control panels containing devices shall be equipped with a hinged panel, and all devices inside each panel, shall bear engraved identifications as shown on submittal drawings. Do not attach nameplates to devices, rather attach to mounting back plane. All devices shall be wired through a wiring terminal strip located within the panel. Each terminal shall be identified to match submittal drawings.

B. Sensors.

1. General: Temperature sensors for duct, immersion, remote probe, and outside air applications.

a. Sensor time constant response to temperature change time shall be less than 3 seconds per degree change. Sensors requiring field-calibration shall not be acceptable. All sensors shall be precise and accurate so that they do not require adjustments or calibrations. Linearizing, ranging, and resistance change versus temperature curve interpretations, where required, shall be made by software programming.

b. Minimum sensor operating ranges shall be as follows:

| | | |
|---|---|---|
| 1) | Chilled Water | 30°F to 100°F. |
| 2) | Condenser Water | 30°F to 150°F. |
| 3) | Air Systems | 0°F to 150°F. |
| 4) | Outside Air | 0°F to 120°F. |
| 5) | Hot Water | 40°F to 240°F |

c. Sensor accuracy shall be ±0.1% at 32°F for platinum and nickel sensors and ±0.4°F for thermistor sensors. Sensor to controlling device end to overall system accuracy, including errors associated with the sensor, lead wire and analog to digital conversion shall be ±0.5°F for platinum and nickel sensors and ±1°F for thermistor sensors.

2. Duct Sensors: Flanged or threaded probe type sensors designed for duct type mounting shall be used. Sensor shall be encapsulated in an aluminum probe and extend 25% into the widest cross-sectional duct area except where averaging sensors are specified. Sensors shall include a suitable junction box for terminating sensor wiring and shall include a lagging protrusion where installed in externally insulated ducts. Adjacent to each sensor provide a test hole plugged with a removable cap or plug to be used for test and calibration purposes. All sensors shall be located in the most easily accessible location while providing accurate sampling. The air side sensors need to be in the dependable section of the air path. The device shall dampen the reading and the response.

3. Immersion Sensors: Immersion type sensors with a 1/2" OD threaded fitting for direct installation in a thermo well shall be used. The probe shall be encapsulated in an aluminum, brass or stainless-steel jacket and shall be installed in a stainless steel thermowell suitable for installation in a 3/4" NPT threaded fitting. Sensors shall include a suitable junction box for terminating sensor wiring. Thermowells shall have pressure and temperature ratings suitable for their application and to be installed by manufactures recommendations. Wells for insulated piping shall have a 2- 1/2" lagging protrusion. Locate wells so the sensing probe will give a true and correct reading. Install wells on the sides of pipes and so as not to cause undue restriction in small piping. Where wells are located in pipelines 1-1/2" and smaller, provide a section of pipe of such diameter that the net area of the pipeline will not be reduced by the thermometer well. All wells shall be filled with silicon and complete with caps and chains.
   Temperature probes and wells shall have the following insertion lengths.

| Pipe Diameter | Orientation | Insertion Length |
|---|---|---|
| 4" | Horizontal | 2-1/2" |
| 4", 6" | Vertical | 4-1/2" |
| 6", 8" | Horizontal | 4-1/2" |
| 8", 10" | Vertical | 6-1/2" |
| >8" | Horizontal | 6-1/2" |
| 10" | Vertical | 10" |

4. Remote Probe Sensors: Remote probe sensors with sensing elements encapsulated in a nominal 2" stainless steel sheath suitable for return air or strap-on mounting shall be used. Sensors shall include a nominal 3' lead section and a suitable junction box for terminating sensor wiring.

5. Outside Air Sensors: Shielded, weatherproof outside air sensors with sensing elements encapsulated in a nominal 2" stainless steel sheath suitable for outdoor applications shall be used. Sensors shall include a waterproof junction box or conduit body for terminating sensor wiring and a removable sun shield. Location shall be on exterior North-facing sidewall at a level requiring a 6’ stepladder for servicing. Do not install at ground accessible level.

6. Space temperature sensors shall be electronic type with a range measuring near midpoint of the control process. These sensors will have no field calibration but will be provided with a zero and span adjustment. They will have an accuracy of ±0.4°F. All sensors shall use shielded cable between the sensor and the controller. Space temperature sensors for use with ASC’s shall only be provided with, local occupancy switch and occupancy status indication.

C. Pressure Sensors

1. Overpressure Protection: Provide pressure sensors impervious to instantaneous pressure changes of 150 percent of working pressure.

2. Adjustment: Provide sensors with external adjustable span, adjustable zero and pulsation suppression (averaging type).

3. Finished Spaces: Conceal pressure sensors in recessed stainless-steel housing with removable perforated brushed stainless-steel cover.

4. Sensor Characteristics: Provide pressure sensors with the following characteristics:

a. Must withstand an Ambient Temperature: 40 to 140 degrees F.

b. Isolation Valves: Provide pressure sensors with ball type isolation valves between each sensor and sensor pressure source.

c. Siphon: On steam systems provide pressure sensors with a pigtail siphon between the sensor isolation valve and sensor. Provide condensate wells and blowdown valves for differential pressure sensors.

d. Provide switching type sensors with platinum alloy, silver alloy or gold-plated wiping contacts rated for the application, voltage, and power levels.

e. Provide valved calibration taps adjacent to each pressure sensor for calibration.

D. Differential Pressure Analog Sensors

1. Types: Provide differential pressure analog sensors of the solid-state preamplifier types for electronic systems.

E. Flow Sensors

1. General: Provide sensors for measuring flow in piping and ductwork that are compatible with static pressure and differential pressure analog inputs of the electronic controllers served.

2. Turndown: Provide sensors with an output which gives a continuous mathematical function over the full range of flow from maximum to minimum required.

3. Location: Mount flow sensor concealed in public spaces or exposed in

mechanical equipment room. All devices must be accessible for service.

F. Water Differential Pressure Sensors.

1. Types: Provide digital electronic pressure sensors as required by the Sequence of Operations and control diagrams.

2. Provide sensing elements of the differential type measuring controlled medium and standard reference pressures.

3. Water differential pressure sensors shall have a minimum range of 0 to 50 psid with overpressure protection as required by the application.

G. CO2 Sensors.

1. The $CO_2$ sensor for demand control ventilation must use technology appropriate to the application. If sensor is designed to have a life span beyond 5 years, all adjustments to the sensor including output signal, output scaling, relay set point, relay dead-band, resetting $CO_2$ calibration, and full two point calibration capabilities should be made via a user friendly PC based program or factory hand held device that can communicate with the sensor.

2. Sensor shall have 20-30 VAC power input, 0-10V or 4-20mA analog output max. range, 0-10,000 ppm max. or factory set 0-5000 ppm measuring range.

3. Sensor shall be manufactured and warranted for 1 year by the control's vendor. During the initial 1-year period, recalibration required to keep instruments within 10% of the original manufacture's specifications shall be performed by the control's vendor at no cost to NMSU.

H. Actuators

1. Electric Actuators: Provide hydraulic or gear type electric actuators.

a. When operated at rated voltage, each actuator shall deliver the torque required for continuous uniform movement of the control device from limit to limit.

b. Provide an integral end switch to limit travel and design the actuator to continuously stroke without damage.

c. Operators shall function properly within a range of 85% to 120% of line voltage. For actuators with input power greater than 100 watts, gears shall be ground steel, oil immersed, shaft shall be hardened steel running in bronze, copper alloy or ball bearing and operator and gear trains shall be totally enclosed in dustproof cast iron, cast steel or cast aluminum housing.

d. Actuators with input power less than 100 watts may use fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings and pressed steel enclosures.

e. Two position actuators shall be of the single direction, spring return or reversing type.

f. Proportioning operators shall be capable of stopping at all points in the cycle and starting in either direction from any point.

g. Reversing and proportioning operators shall have limit switches to limit travel in either direction.

h. Electric valve operators shall be equipped with a spring yield device to maintain control pressure on the valve disk when the actuator is in a relaxed position.

i. For actuators with greater than 400 watts input, provide totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

j. Modulating Control Operators: Provide all modulating control valves 2" and larger and all sizes of butterfly valves with a positive positioning power device. Such device shall operate independently of valve spring range or stem friction to ensure the repetition of valve position when related to the same signal increment value of controller output. Positioner sensitivity shall be sufficient to produce a stem travel reversal loss not exceeding 7% of the controller output range as it goes from its full to no-load position within its proportional band operation. Provide positioners whenever required to obtain close-off ratings or proper sequencing of valves.

2. Damper Operator Mounting: Mount damper operators where accessible for maintenance.

a. If located outside the duct or casing, mount operators on a 14-gauge reinforced support plate arranged to allow insulation between the support plate and the face of the duct or casing.

b. Brace damper operators rigid to show no deflection or movement over the full range of the damper stroke.

I. Differential Pressure Switches (Hydronic)

1. Differential Pressure (DP) Water Flow Switches: Switches shall be double bellows type differential pressure switches with brass bellows directly actuating a snap-acting Double Pole Double Throw (DPDT) switch.

Switches shall have visible set point adjusters. Switches exposed to weather shall be weatherproof. Switch ranges and set points shall be appropriate to

the manufacturer's recommendations for the pressure at the point of application and the differential pressure being monitored. (install at approximately 2/3 to 3/4 of the distribution system away from the pumps.)

J. Current Sensing Relays

1. Relays shall monitor AC current of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for switching controller DC current as required. The set point of the contact operation shall be field adjustable.

K. Static Pressure Safety Switch

1. Air pressure switch shall be manually reset type, Double Pole Double Throw (DPDT) designed to sense static pressure and break an electrical circuit when the setpoint is exceeded. The setpoint shall be adjustable from 0.4" to 12" W.C. Unit shall be furnished and installed with a static pressure tip.

L. Duct Static Pressure Probes

1. Provide at each location indicated a duct static pressure probe capable of continuous monitoring of air static pressure. Each probe shall contain multiple static pressure pick-up points along the exterior surface of the cylindrical probe, internally connected to the averaging manifold. The station shall produce no measurable system pressure drop.

2. Each probe shall be constructed of extruded aluminum with threaded end support rod and nut and mounting plate gasket.

3. The probe shall produce a non-pulsating signal with a total accuracy of 0.5 percent of the total span.

M. Building Static Pressure Probes

1. Outside air static pressure probe shall be constructed of 10-gauge, anodized aluminum with a 2" diameter FPT connection. The probe shall be capable of sensing the outside atmospheric air pressure to within 2% of the actual value when subject to radial wind velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal.

2. Indoor static air probes shall be provided for each indoor air pressure measurement location. They shall be flush mounted with a concealed connection. They shall be constructed of 10-gauge aluminum with a 1/8" coupling for output signal connection.

N. Chilled Water Meters

1. Chilled water meter capacity specification will be determined by the design engineer. Specification and typical guideline drawings will be provided by

NMSU Project Representative for design of equipment installation.

2. Chilled water meters shall have a maximum operating pressure of 150 psig. Flow meter shall be installed with ball valve for hot insertion. Temperature sensors shall use immersion wells. BTU meter shall have LCD display for BTU flow rate and flow totalization.

3. Flow meter shall be furnished with a BACnet IP communications interface. (install per manufacturer's recommendations).

4. A minimum of 5' clearance shall be maintained to facilitate the ease of repair, maintenance, removal and replacement of the flow meter without the need for specialized equipment.

5. Meter shall not incorporate any moving parts on the flow sensing element.

O. Condensate Meters

1. Condensate meter capacity specification will be determined by the design engineer. Specification and typical guideline drawings will be provided by NMSU Project Representative for design of equipment installation.
2. Meter will consist of a full-bore body with encapsulated and rigidly retained set of coils. Meter will provide instantaneous and totalized flow available at local indicator or remotely through outputs. Meter shall be installed to insure full liquid emersion at all times. Meter will measure fluids with conductivity greater than or equal to 5.0 us/cm2.
3. Meter shall be equipped with electronics capable of interfacing with an energy management system via BACnet IP communication protocol.
4. A minimum of 5' clearance shall be maintained to facilitate the ease of repair, maintenance, removal and replacement of the flow meter without the need for specialized equipment.
5. Meter will have uniform magnetic field flux distribution eliminating piping straight run and flow profiling.

P. Natural Gas Meters

1. Natural gas meter capacity specification will be determined by the design engineer. Specification and typical guideline drawings will be provided by NMSU Project Representative for design of equipment installation.

2. Meter shall be equipped with electronics capable of interfacing with an energy management system via BACnet IP communication protocol.

O. Actuators General

1. General: Provide electric motor driven actuators (operators) arranged "Fail Safe" in the event of power failure.

2. Electric Actuators: Provide hydraulic or gear type electric actuators.

3. When operated at rated voltage, each actuator shall deliver the torque required for continuous uniform movement of the control device from limit to limit.

4. Provide an integral end switch to limit travel and design the actuator to continuously stroke without damage.

5. Operators shall function properly within a range of 85 to 120% of line voltage. For actuators with input power greater than 100 watts, gears shall be ground steel, oil immersed, shaft shall be hardened steel running in bronze, copper alloy or ball bearing and operator and gear trains shall be totally enclosed in dustproof cast iron, cast steel or cast aluminum housing.

6. Actuators with input power less than 100 watts may use fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings and pressed steel enclosures.

7. Two position actuators shall be of the single direction, spring return or reversing type.

8. Proportioning operators shall be capable of stopping at all points in the cycle and starting in either direction from any point.

9. Reversing and proportioning operators shall have limit switches to limit travel in either direction.

10 Electric valve operators shall be equipped with a spring yield device to maintain control pressure on the valve disk when the actuator is in a relaxed position.

11 For actuators with greater than 400 watts input, provide totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

1.3 AUTOMATIC VALVES

A. General: Provide factory-fabricated two-way or three-way valves with two position or modulating control actuators of the type, body material, and pressure class required for each application. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements. Valve pressure class and rating shall be selected based on maximum pressure and temperature in the piping system in which it is installed.

B. Performance: All valves shall conform to the following minimum standards and selection requirements.

1. Valves shall be guaranteed to have bubble-tight shut off.

2. Provide heavy-duty actuators, with proper close-off rating for each individual application.

3. The valve assembly shall be suitable for throttling control and for tight shut- off against pump shut-off head. All valves shall be certified by an authorized officer of the manufacturer to shut-off bubble-tight against full system pump shut-off head.

4. All valves which are operated in sequence with damper motors, control switches, or other valves shall sequence properly without overlap. Provide positive positioners, oversized operators, or balanced trim if required for proper sequence control.

5. Valve schedules submitted for review shall clearly show shift in operator span for all valves operated in sequence and shut-off capability for all valves.

6. Valves for steam service shall be of globe style and designed for high temperature service with positive shut-off at or above normal operating pressure.

7. Valves used on main air handling units shall be equipped with manual value handle. to allow for continued operation of an AHU during control system servicing.

8. Valves used in steam applications shall operate normally under extreme heat conditions (in excess of 300° F) with no external fan or air movement required.

9. Steam valve actuators must be rated to operate under high temperature conditions with a mean temperature operating range of approximately 250 deg F (Siemens SDK electro-hydraulic type actuator or approved equal).

C. Valve Types:

1. Two-Way Valves: Provide straight through pattern-type, union globe valves. Valves 1/2" to 2" in size shall have bronze, brass, stainless steel or approved corrosion resistant bodies and screwed ends. Valves 2-1/2" and larger shall have high-tensile cast iron or cast steel bodies, bronze stainless steel with flanged connections. All seats and trim and valve stems shall be 316 or 416 stainless steel. Valves shall be designed to provide equal percentage flow characteristics at constant pressures with an operating range of 300 to one. Low-pressure valves shall be provided with a repairable valve and seat.

2. Three-way Valves: Provide straight through and perpendicular pattern- type, union globe valves. Valves 1/2" to 2" in size shall have bronze, brass, stainless steel or approved corrosion resistant bodies and screwed ends. Valves 2-1/2" and larger shall have high-tensile cast iron or cast steel bodies, bronze stainless steel with flanged connections. All seats and trim and valve stems shall be 316 or 416 stainless steel. Valves shall be designed to provide equal percentage flow characteristics at constant pressures with an operating range of 300 to one. Low-pressure valves shall be provided with a repairable valve and seat.

3. Butterfly Valves: Where indicated on the Drawings or required by the

Sequence of Operations, utilize full lug butterfly-type control valves rated for the same operating pressure as the piping system in which such valves are installed. Valves shall have bubble-tight shut-off against either side of the valve when the flange is removed from the opposite side. Provide positive positioners or oversized operators if required for proper sequence control.

4. Differential Bypass Valves: Valves for control of differential bypass systems shall be of industrial quality with minimum 50:1 operating range, equal percentage characteristics, cast iron body, 316 stainless steel trim, position indicator, heavy duty operator, stainless steel stem, Teflon spring- loaded packed. All working parts (trim) of the valve shall be replaceable without removing the valve body from the line.

5. Small Valves: Small (one inch [1"] and smaller) heating hot water and chilled water valves shall be of the three-way or straight-through equal- percentage type with polished stainless steel stems, spring-loaded Teflon or rubber packing to allow the valve to be repacked.

D. Fail Position: Chilled water and steam valve fail positions shall be determined by design criteria on a case-by-case basis.

E. Valve Selection: All valves shall be suitable for the maximum design pressure temperature and flow to meet the engineer's design specification of the system in which they are installed.

1. Properly sized temperature and pressure relief valves shall be installed in all hot water systems and shall be piped to the nearest floor drain per state and/or local code for discharge water temperature of less than 140 degrees. For temperatures higher than 140 degrees, coordinate drainpipe design to meet maximum discharge temperature potential.

2. Properly sized steam pressure relief valves shall vent to atmosphere. A trip-stop valve is acceptable where venting to atmosphere is impossible or impractical.

1.4 WIRING

A. All wiring shall conform to the requirements of the NFPA 70 and Division 26 specifications. All control, power, and communication wiring of all voltages, including wiring in mechanical rooms, shall be run in minimum ¾" EMT. Control and power cables are NOT to be placed in the same conduit with communication cables.

B. Wiring:

1. All wiring used must comply in every detail to wiring standards as set forth by the system and/or device manufacturer.

2. Wire for low voltage AC shall be minimum 300 volt insulated copper No.18 AWG or larger conforming to NFPA 70, Type MTW, THHN, or TFFN.

3. Cables carrying analog signals shall be shielded.

4. Cables shall be terminated in solder or screw type terminal strips.

5. Cables shall not be tapped at any intermediate points.

6. All wire shall be color coded or numbered for identification. Identify as indicated on shop drawings and "As-Built" drawings. Cables and conductors shall be tagged at both ends with the identifier shown on the shop drawings.

7. Wire terminating in screw type terminal strips shall have pressure connectors conforming to UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors, or UL 486B, "Wire Connectors for Use with Aluminum Conductors."

8. Wire terminations without connectors or traveling pressure pads will not be accepted.

## PART 3 - EXECUTION

### 3.1 FIELD DEVICE INSTALLATION

A. Space temperature transmitters shall be installed 48" A.F.F., unless otherwise specified on the plans.

B. All temperature sensors installed in liquid lines, tanks, etc., shall be installed in stainless steel thermowells. To be installed per manufactures requirements.

C. Outdoor air temperature elements shall be installed on North facing wall or structure in a location that is continuously shaded and not effected by heat generating equipment or equipment intakes or discharges. The element shall be installed under a sun shield and high enough to avoid damage from vandalism.

D. Duct point temperature elements shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. Care must be taken to avoid direct contact between the temperature element and any heat transfer surface such as a coil.

E. Duct averaging elements will be extended across the entire duct area in a zigzag pattern covering the entire surface area. Special clips will be used to secure the elements at turns to prevent chafing of the elements. Where elements pass through sheet metals penetrations, a duct plastic tubing or

similar protection will be installed on the elements to prevent damage to the elements from vibration.

F. Duct static pressure stations will be installed so that the direction of flow is observed when installing the probe to prevent measurement of total pressure. The connection between the duct and the flange will be gasketed and secured with sheet metal screws to prevent any air leakage. Connections from the "HI" pressure port to the differential pressure transducer will be 1/4" plastic tubing and not extend for more than ten feet. Pressure stations will be installed no less than 2/3 the distance of the main duct away from any branch ducts or change of direction.

G. All air differential pressure transmitters will be installed within ten feet of the pressure sensing point. The transmitters shall be installed in a NEMA 1 housing for interior conditioned spaces and in NEMA 3R housings for outside or unconditioned spaces. The transmitters and housings will be rigidly supported to prevent vibration and shall never be mounted to ductwork or piping. Transmitter will be installed so that it is easily serviced.

H. Outdoor humidity transmitters will be installed in a manner so that external influences will not affect the accuracy of measurement

I. Duct point humidity elements shall be installed directly on ductwork and the connection between the duct and the flange shall be gasketed and secured with sheet metal screws to prevent any air leakage. The sensing element will be installed per manufactures requirements.

J. Space humidity transmitters will be installed at 48" A.F.F. unless otherwise specified on the plans.

K. Current switches will be installed in one leg of three phase circuits and the hot leg of single-phase circuits and in all cases, after the local disconnect. The switches will be adjusted to close at approximately 10% of the attached loads full load amps.

L. Low limit thermostats will be installed with the averaging element extended across the entire duct area in a zigzag pattern. Special clips will be used to secure the element at turns to prevent chafing of the element. Where elements pass through sheet metals penetrations, a duct plastic tubing or similar protection will be installed on the elements to prevent damage to the elements from vibration. The low limit thermostat set point will be set per design requirements and field verified for fail safe operation.

M. All liquid differential pressure transmitters will be installed within ten feet of the pressure sensing points. The transmitter will be rigidly supported to prevent vibration and will never be mounted to ductwork or piping. The piping for the sensing points will include isolation valves such that the transmitter can be removed without having to shut down the liquid system. Transmitter will be installed so that it is easily serviced.

N. Outside air static pressure probes must be installed and piped according to manufacturer's instructions to ensure accuracy of the static pressure reading and eliminate the effects of condensation in the sensing lines. Coordinate installation of probes with the necessary trades for proper sealing of all roof penetrations.

O. Air differential pressure switches will be connected to pitot tube pickup probes pointing into the air stream on both sides of the process variable. Connections between the switch and the pitot tubes shall be 1/4" hard copper.

## 3.2 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

Comply with all Division 26 installation requirements. All control, power, and communications wiring shall be installed in conduit.

A. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

B. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

C. All wire-to-device connections will be made at terminal blocks or terminal strip. All wire-to-wire connections shall be at a spring cage type terminal

block. All wiring within enclosures will be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

D. Cap all unused conduit openings and stub-ups. Only use fire rating caulking when required by fire code.

E. Route all conduit to clear beams, plates, footings, and structure members. Do not route conduit through column footings or grade beams.

F. Set conduits as follows:

1. Expanding silicone fire stop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.

G. Cap open ends of conduits until conductors are installed.

H. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18" and maximum length of 36" shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

I. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit will be installed. Installation shall be as specified for flexible metal conduit.

J. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors, or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

- end of section -

# SECTION 26 00 00 - ELECTRICAL GENERAL REQUIREMENTS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes general electrical work requirements, such as:
   1. Summary of Scope of Work
   2. Submittal, qualifications, quality assurance, & warranty requirements
   3. Storage and handling requirements
   4. Coordination requirements
   5. Safety requirements
   6. Shoring and supporting requirements
   7. Temporary construction power and lighting

C. The scope of work shall include complete provisions for electrical power distribution to all lighting, devices, appliances, and equipment shown on the construction documents.
   1. Provisions include, but are not limited to, all supplies, materials, equipment, tools, and labor.
   2. Provisions also include all miscellaneous materials required to complete the work shown including, but not limited to, supports, hangers, raceways, boxes, sleeves, seals, equipment pads, wiring connectors, terminals, labels, signs, and markers
   3. The construction documents include all plans, elevations, details, diagrams, schedules, and notes on the drawings and the written specifications including any items mentioned in either the specifications or on the drawings but not in the other.
   4. Where used on the plans and in the specifications and where not specifically noted otherwise, the term “provide” and the term “install” shall mean furnish, install, connect, and test.
   5. Unless explicitly noted “by others” or “existing”, all items shown graphically or specified by notes and details on the plans shall be furnished, installed, connected, and tested as needed.

D. In addition to the general scope described above, the work shall include:
   1. Equipment rental.
   2. Provisions for maintaining the functionality of existing to remain building communications, fire alarm, security/access control, public address, and bell systems that will be affected by the work.

E. The intent of the drawings and specifications is to set forth the general requirements and equipment necessary for the functioning of the electrical system. The drawings and specifications do not provide a complete list of materials and work required. All miscellaneous electrical components required by good practice and workmanship for the complete installation of the electrical system shall be provided by the contractor.

F. The electrical contractor shall be responsible for all controls raceways, where required, and boxes to serve devices and equipment shown or described on the construction documents even where such devices and equipment will be provided by a specialist contractor and/or a contractor working directly for the owner such as communications, fire alarm, HVAC controls, security/access control.
   1. Unless noted otherwise, all control wiring shall be by specialist contractor.
   2. Electrical contractor shall be responsible for 120 through 480V power required for controls systems such as fire alarm panels and extension panels, server racks, HVAC equipment 120V control and maintenance circuits, etc.

G. Related Sections:
   1. This and all other division 26 specifications, the construction drawings, general contract provisions, and division 1 specifications shall be considered collectively as the total general requirements for the electrical equipment and electrical system installation and all special systems shown or described on the electrical or "E series" sheets.

## 1.2 REFERENCES

A. Materials, equipment, and the work performed shall comply with current requirements, rules and regulations of and, where applicable, be certified by the following standards, codes and organizations:
   1. American National Standards Institute (ANSI)
   2. American Society for Testing and Materials (ASTM)
   3. Americans with Disabilities Act (ADA)
   4. ASHRAE/IES 90.1
   5. Institute of Electrical and Electronics Engineers (IEEE)
   6. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code
   7. IEEE C57.12.28 (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
   8. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms
   9. National Electrical Manufacturer's Code (NEMA)
   10. NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
   11. National Fire Protection Associations (NFPA)
   12. NFPA 70 National Electrical Code - 2017 Edition
   13. Underwriter's Association (UL)
   14. Where discrepancies are found between the requirements of these standards codes, ordinances, regulations and the drawings and specifications, the contractor should notify the engineer prior to installation. Installed work that fails to comply with the requirements of the above shall be replaced at contractor's expense.

## 1.3 DEFINITIONS

A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

B. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

C. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 SUBMITTALS

A. Submittal requirements shown here shall be used in conjunction with the requirements of the other specification sections. Where in conflict, the more stringent requirements shall apply.

B. Submit the following:
1. Permitting, inspection, and final acceptance certifications from the authority having jurisdiction.
2. A contractor prepared drawing of the electrical rooms showing dimensioned electrical equipment and house keeping pad locations.
3. A contractor prepared drawing of the site indicating the routing of site service conduits for power and special systems as well as feeder conduits over 2” in diameter.

C. For each product required to be submitted, provide the following
1. Product Data: Submit catalog data showing manufacturer’s name and contact information, all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
a. Include amperage and voltage ratings, over-current protective device ratings, AIC ratings, etc
b. Where multiple sizes are listed, indicate sizes to be used.
c. Where multiple products are shown on the same page, indicate which products to be used.
2. Shop Drawings (where applicable): Manufacturer or contractor prepared drawings showing all relevant dimensions, weights, electrical and mechanical connection requirements, conduit entry points, assembly requirements, lifting requirements, lifting points, and required clearances.
a. Include dimensioned plan views and elevations.
b. Include all relevant electrical diagrams including schematic and interconnection diagrams for power, signal, and control wiring.

D. Submittals shall be organized by specification section, provided with a table of contents, and a cover page with all pertinent project information including contractor’s name and contact information, project name and number, and specification sections submitted.

E. All submittals shall be submitted in PDF format.

F. Rejected submittals shall be resubmitted within two weeks of notification of rejection.

G. Any equipment covered by division 26 specifications that is installed by the contractor without submittal approval and is not in compliance with the appropriate specifications shall be replaced at the contractor’ expense.

H. As-Built Record Drawings: The Contractor shall maintain a master set of As-Built Record Drawings that show changes and any other deviations from the drawings. The markups must be made as the changes are done. At the conclusion of the job, these As-Built Record

Drawings shall be transferred to AutoCAD electronic files, in a format acceptable to the Owner, and shall be complete and delivered to the Owner's Representative prior to final acceptance.

1.5 CLOSEOUT SUBMITTALS

A. At the end of construction, provide a closeout submittal containing the following information in addition to items specified in other sections.
   1. As built drawings showing the actual locations of installed equipment, site raceways and boxes, and feeders rated 100A or more and concealed behind walls or in slabs.
   2. Operation and Maintenance data
   3. Shop Drawings
   4. Test results
   5. Actual circuit arrangements at panels and equipment. Provide complete, typed as built of all panel schedules.

B. Operation and Maintenance Data: At the end of construction, provide the owner with both an 8.5x11 bound manual and an electronic copy of PDF files including the following information:
   1. Provide product data as defined under submittals.
   2. Provide manufacturer's installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
   3. Spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

C. Shop Drawings: At end of construction, provide owner with a final draft, new copy of all shop drawings that were field modified after the original submittal was approved.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products shown on the construction documents with minimum three years documented experience.
   1. Manufacturer shall maintain or certify an independently operated service center capable of providing training, support, parts, and maintenance services.

B. Supplier: Authorized distributor

C. Installer: A state licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications, required by code, or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.7 QUALITY ASSURANCE

A. Inclusion of specific products in these specifications and on the plans, does not mean that said products may be used for all applications in all environments. Products may only be used where approved either in the specification installation requirements sections or on the plans. Where the construction documents do no explicitly state what products are acceptable for an application, the most robust products specified are assumed to be the minimum requirement.

B. Regulatory Requirements
   1. The contractor shall comply with the requirements of all laws, rules, regulations, code and ordinances that have been adopted by the federal, state, and local authorities having jurisdiction (AHJ). All equipment, materials, means and methods shall be acceptable to the AHJ's.
   2. Electrical installations shall conform to IEEE C2, NFPA 70, local codes and specified requirements herein. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.
   3. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. Standard Products
   1. Unless otherwise approved, all equipment shall be new, properly designed, from a reputable manufacturer meeting the specification qualifications, in compliance with the specification requirements, and in full working order.
   2. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.
   3. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.
   4. Products shall have been in satisfactory commercial or industrial use prior to bid opening. The minimum time of use shall be 2 years. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. Longer periods may be specified for specific products. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

D. Alternative Qualifications
   1. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

E. Material and Equipment Manufacturing Date
   1. Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

F. All equipment used for testing shall be in full working order and calibrated per the manufacturer's recommendations.

1.8 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.9 COORDINATION

A. All power outages shall be coordinated in writing with the owner a minimum of one (1) week prior to the outage.

B. If the owner will occupy any portion of the facility during any period of construction, cooperate fully with the owner or his representative during construction operations to minimize conflicts and to facilitate owner usage so as not to interfere with the owner's operations.

C. The drawings are diagrammatic. They do not show switches, power and data outlets, special systems components (FA, Access Control, AV, etc), electrical equipment, equipment connections, required raceways, etc. in their exact dimensioned locations. The contractor must carefully review the architectural, structural, mechanical, plumbing, fire protection, and special systems plans to identify conflicts and areas that require coordination.

D. Coordinate electrical and special systems equipment rough in with millwork, signs, mechanical and plumbing systems, sprinkler systems, architectural and structural elements, and the owner's representative. Minor changes in electrical equipment locations and layout that are required by site conditions or order by the design team prior to performance of work shall be made by the contractor without additional charges to the owner.

E. Maintain required NEC working space and dedicated equipment spaces around all electrical equipment, control panels, etc that are subject to maintenance, testing, or user interface. Coordinate with other trades prior to installation. If clearance cannot be provided, the contractor shall notify the engineer prior to rough-in.

F. Coordinate color selections for luminaires and all device plates with architect.

G. Contractor shall be responsible for field coordinating with other trades.

H. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So, connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
   5. To allow for the appropriate installation of furniture and equipment relative to receptacles and switches.

I. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

J. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

K. Coordinate sleeve selection and application with architect and structural engineer.

L. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

M. Determine connection locations and requirements.

N. Sequence rough-in of electrical connections to coordinate with installation of equipment.

O. Sequence electrical connections to coordinate with start-up of equipment.

1.10 DELIVERY STORAGE AND HANDLING

A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.

B. Maintain factory wrapping or provide additional canvas or plastic cover for all large electrical equipment. Follow all manufacturer recommendations for humidity and max/min temperatures for storing electrical equipment.

1.11 SAFETY

A. The Contractor shall follow all industry standard safety procedures
   1. The Contractors shall be responsible for training all personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel of hazards particular to this project and update the information as the project progresses.
   2. The Contractor shall secure all electrical rooms, to limit access, prior to energizing any high voltage switchgear and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is on going near energized equipment. The Contractor shall cover all energized live parts when work is not being done in the equipment. This includes lunch and breaks.
   3. The Contractor shall strictly enforce OSHA lock out/tag out procedures. Initial infractions shall result in a warning; a second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

1.12 SHORING AND EQUIPMENT SUPPORTS

A. Provide all permanent and temporary bracing, anchoring, supports, and shoring required to firmly stabilize and secure all raceways, boxes, enclosure, equipment, and devices.

B. Provide free standing racks to supports equipment. Racks shall be securely bolted to the floor, wall, and or ceilings. Where secured to only one surface, provide angle bracing so that racks have a minimum of 4 attachment points.

C. Provide concrete housekeeping pads for floor mounted electrical equipment. Coordinate with flooring contractor for installation.
   1. 3000PSI, with rebar reinforcement.
   2. Provide dowels for connection to new or existing adjacent slabs
   3. Pad shall be 4” thick and protrude a minimum of 1” beyond the edge of equipment.

4. Chamfer top edges of slab

## PART 2 PRODUCTS

### 2.1 GENERAL REQUIREMENTS

A. Equipment to be installed outdoors, in corrosive or hazardous environments shall be rated for the intended use.

B. Compliance with the requirements of the contract documents shall not relieve the contractor of the responsibility of providing equipment that is new, properly designed, from a reputable manufacturer, and in full working order.

C. If conflicts occur between the specifications and drawings, the higher quality, price or quantity shall be provided and installed.

D. If there is any question as to quality, size or quantity necessary, the contractor shall provide a written request for clarification from the Engineer. Contractor shall be responsible for any additional expenses incurred as a result of the contractor's failure to obtain clarification.

E. Detailed product specifications are included in other specification section and on the plans.

### 2.2 FINISHES

A. Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

B. Raceways, boxes, supports, etc. shall be galvanized: gold, silver, or hot dipped, unless noted otherwise.
   1. Do not use pre-galvanized products that are formed, cut, or punched after galvanization.
   2. Do not use hot dip galvanized threaded products.

### 2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time,

## PART 3 EXECUTION

### 3.1 FIELD APPLIED PAINTING

A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.2 FIELD PROGRAMMING

A. Electrical contractor shall be responsible for the coordination and payment of programming for all programmable devices and equipment including, but not limited to, lighting controls, circuit breakers, interfaces with building automation system, power monitoring equipment, etc.

B. Where required, the manufacturer of the product shall be engaged to perform the programming.

3.3 EXAMINATION

A. If a conflict is found between the specification and plans, notify the Architect or Engineer of the conflict.

B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

C. Verify existing conditions are as shown on the plans and that adequate space is available for the equipment for installation.

3.4 EXISTING WORK

A. Maintain in service existing systems that are required for life safety or ongoing operations during construction.

B. Remove exposed abandoned equipment wiring connections, conduit, and boxes, including abandoned connections, conduit, and boxes above accessible ceiling finishes.

C. Disconnect abandoned utilization equipment and remove wiring connections. Remove abandoned components when connected raceway is abandoned and removed. Install blank cover for abandoned boxes and enclosures not removed.

D. Extend existing equipment connections using materials and methods compatible with existing electrical installations, or as specified.

3.5 INSTALLATION

A. The installation requirements shown here are general scope requirements. More detailed information is provided for each of these topics in other specifications and on the plans.

B. No foreign systems such as piping, duct work, etc shall be installed above electrical equipment.

C. Grounding and Bonding
   1. All circuits shall be provided with NEC compliant green ground conductor sized per NEC 250, UNO.
   2. All equipment shall be properly bonded.
   3. Provide grounding electrodes as specified on plans and as required by code.

D. Raceways, Boxes and Enclosures
   1. Where noted, provide complete raceway systems from source to all loads with dedicated supports for each raceway element.

2. Provide all required back boxes and supports for wiring devices, telecommunications, fire alarm, access control, controls equipment, alarms, sensors, etc.
3. Provide pull box at appropriate locations for all power and special systems raceways whether shown on plans or not.
4. Low voltage cabling may be run without raceways where noted and permitted. All wiring shall be properly supported with J-hooks or other appropriate method. Specialist contractor will be responsible for all supports

E. Electrical connections and terminations.
1. Make all connections and terminations within the power distribution system and between the distribution system and the equipment served.
2. Make conduit connections to vibrating equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
3. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
4. Provide calibrated torque wrenches and screwdrivers and tighten terminals, lugs and bus joints using it.

F. Equipment wiring requirements
1. Install disconnect switches, controllers, control stations, and control devices as required for equipment.
2. Install terminal block jumpers to complete equipment wiring requirements.
3. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
4. Install control wiring to interlocks, sensors, and remote operator interfaces provided with equipment such as generators, roll-up doors, dock levelers, etc

G. Identification
1. Provide appropriate labels for all equipment, wiring devices, conductors, cables, box, and enclosures
2. Provide warning signs for electrical equipment and buried circuits.

H. Code and manufacturer requirement compliance
1. Install work in compliance with the latest edition of the NEC, City and Owner design criteria manuals, and the authority having jurisdiction.
2. Apply, install, connect, erect, use, clean, adjust, and condition materials and equipment as recommended by the manufacturers in their published literature.
3. All terminals, lugs and bus joints shall be tightened per the manufacturer’s torque recommendations.

I. Arrangement and planning
1. Arrange electrical work in neat, well-organized manner.
2. Do not block future connection points of electrical service.
3. Install all electrical work parallel or perpendicular to building lines unless noted otherwise, properly supported with purpose-designed apparatus, in a neat manner.
4. Maintain required NEC working space and dedicated equipment spaces around all electrical equipment subject to maintenance, testing, or user interface. Coordinate with other trades prior to installation.

5. Do not block equipment control panels with lighting, raceways, structural elements or other equipment. Orient equipment so that control panels do not face structural elements or other equipment that will restrict access.
6. Coordinate with engineer before installation if any of the above conditions can not be met due to undiscovered site conditions or if locations shown on plans are field determined to be in conflict with equipment and structures called for on other plans.

J. Cutting and Patching
1. Make opening through masonry and concrete by core drilling in acceptable locations. Restore openings to original condition to match remaining surrounding materials.
2. Provide sleeves for penetrations through floors and walls
3. Seal all openings using appropriate materials
4. Where existing conditions are not documented, perform ground penetrating radar scan of structural element to be cut.

3.6 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF DOCUMENT

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# SECTION 26 05 00 - BASIC ELECTRICAL MATERIALS AND METHODS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes general electrical materials and methods. Section covers the following specific items.
   1. Power Meters
   2. Surge Protection Devices
   3. Terminal Blocks
   4. Lighting Contactors
   5. Relays
   6. Phase Monitor Relays
   7. Push Buttons and Selector Switches

C. Related Sections:
   1. This and all other division 26 specifications, the construction drawings, general contract provisions, and division 1 specifications shall be considered collectively as the total general requirements for the electrical equipment and electrical system installation and all special systems shown or described on the electrical or “E series” sheets.

### 1.2 REFERENCES

A. Materials, equipment, and the work performed shall comply with current requirements, rules and regulations of and, where applicable, be certified by the following standards, codes and organizations:
   1. American National Standards Institute (ANSI)
   2. American Society for Testing and Materials (ASTM)
   3. Americans with Disabilities Act (ADA)
   4. ASHRAE/IES 90.1
   5. Institute of Electrical and Electronics Engineers (IEEE)
   6. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code
   7. IEEE C57.12.28 (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
   8. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms
   9. National Electrical Manufacturer’s Code (NEMA)
   10. NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
   11. National Fire Protection Associations (NFPA)
   12. NFPA 70 National Electrical Code - 2017 Edition
   13. Underwriter’s Association (UL)
   14. Where discrepancies are found between the requirements of these standards codes, ordinances, regulations and the drawings and specifications, the contractor should notify the engineer prior to installation. Installed work that fails to comply with the requirements of the above shall be replaced at contractor’s expense.

1.3 SUBMITTALS

A. Submittal requirements shown here shall be used in conjunction with the requirements of the other specification sections. Where in conflict, the more stringent requirements shall apply.

B. Product Data: Submit catalog data showing manufacturer's name and contact information, all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
   1. Include amperage and voltage ratings, over-current protective device ratings, AIC ratings, etc
   2. Where multiple sizes are listed, indicate sizes to be used.
   3. Where multiple products are shown on the same page, indicate which products to be used.

C. Rejected submittals shall be resubmitted within two weeks of notification of rejection.

D. Any equipment covered by division 26 specifications that is installed by the contractor without submittal approval and is not in compliance with the appropriate specifications shall be replaced at the contractor' expense.

1.4 CLOSEOUT SUBMITTALS

A. At the end of construction, provide a closeout submittal containing the following information in addition to items specified in other sections.
   1. Operation and Maintenance data
   2. Test results

B. Operation and Maintenance Data: At the end of construction, provide the owner with an 8.5x11 bound manual including the following information:
   1. Provide product data as defined under submittals.
   2. Provide manufacturer's installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
   3. Spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products shown on the construction documents with minimum three years documented experience.

B. Supplier: Authorized distributor

C. Installer: A state licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications, required by code, or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.6 QUALITY ASSURANCE

A. Inclusion of specific products in these specifications and on the plans, does not mean that said products may be used for all applications in all environments. Products may only be used

where approved either in the specification installation requirements sections or on the plans. Where the construction documents do no explicitly state what products are acceptable for an application, the most robust products specified are assumed to be the minimum requirement.

B. Regulatory Requirements
   1. The contractor shall comply with the requirements of all laws, rules, regulations, code and ordinances that have been adopted by the federal, state, and local authorities having jurisdiction (AHJ). All equipment, materials, means and methods shall be acceptable to the AHJ's.
   2. Electrical installations shall conform to IEEE C2, NFPA 70, local codes and specified requirements herein. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.
   3. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.

C. Standard Products
   1. Unless otherwise approved, all equipment shall be new, properly designed, from a reputable manufacturer meeting the specification qualifications, in compliance with the specification requirements, and in full working order.
   2. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.
   3. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

D. Material and Equipment Manufacturing Date
   1. Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

E. All equipment used for testing shall be in full working order and calibrated per the manufacturer's recommendations.

## 1.7 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

## 1.8 DELIVERY STORAGE AND HANDLING

A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.

B. Maintain factory wrapping or provide additional canvas or plastic cover for all large electrical equipment. Follow all manufacturer recommendations for humidity and max/min temperatures for storing electrical equipment.

PART 2 PRODUCTS

2.1 POWER METERS

A. Manufacturers:
1. ABB
2. Siemens
3. Square D
4. Eaton
5. Substitutions: With engineer approval.

B. Provide Description: Multi-function power quality meter with the following electrical parameters in addition to those shown on the drawings:
1. Voltage, phase to phase and phase to neutral.
2. Current, per phase RMS and 3 phase average.
3. Demand current, per phase.
4. Power factor, per phase and 3 phase total.
5. Real power, 3 phase total.
6. Reactive power, 3 phase total.
7. Apparent power, 3 phase total.
8. Energy (MWH).
9. Reactive energy (MVARH).
10. Frequency.
11. Average demand real power.
12. Total Harmonic Distortion.
13. Transient detection and logging, 65us at 60Hz.

C. Product Features
1. LCD Display
2. ANSI 12.20 Class 0.2 and IEC 62053-22 Class 0.5S real energy accuracy meters.
3. Time of Use metering
4. Trending
5. Waveform Recording
6. Harmonic Distortion Metering
7. Sag/Swell Detection
8. Transient Capture

D. Communications
1. Ethernet port
2. RS-232/RS-485 Port
3. Infrared Data Port.
4. Standard digital and analog I/O

E. Memory Capacity: 800kB min

F. Waveform recording
1. Triggered manually or by alarm.
2. 3-Cycle
3. 256 samples/cycle min on 3 min user configurable channels

G. Current Transformers: ANSI C57.13; 5-ampere secondary, window type with single secondary winding and secondary shorting device, primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

H. Voltage Transformers: ANSI C57.13; 120-volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

I. Provide communications cabling to connect meter to BAS and provide all necessary programming of BAS.

## 2.2 SURGE PROTECTION DEVICES

A. Manufacturers:
1. ABB-Current Technology
2. Siemens
3. Square D
4. Eaton
5. Substitutions: With engineer approval.

B. UL Type 1449 – 4th Edition listed.

C. Product Description: IEEE C62.41, switchboard mounted transient voltage surge suppressor, selected to meet requirements for medium exposure and to coordinate with system circuit voltage.

## 2.3 TERMINAL BLOCKS

A. Manufacturers:
1. Carlon Electrical Products
2. Hubbell Wiring Devices
3. Reliance Electric
4. Substitutions: With engineer approval.

B. Terminal Blocks: NEMA ICS 4.

C. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

D. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

E. Furnish ground bus terminal block, with each connector bonded to enclosure.

## 2.4 LIGHTING CONTACTORS

A. Manufacturers:
1. Automatic Switch Co.
2. Eaton
3. ABB

4. Square D
5. Siemens
6. Substitutions: With engineer approval.

B. Product Description:
1. NEMA ICS 2, magnetic lighting contactor.
2. Configuration: Electrically held, 2 wire control.
3. Coil Operating Voltage: 24 or 120 volts, 60 Hertz.
4. Poles: To match circuit configuration and control function.
5. Contact Rating: Conductor overcurrent protection, considering derating for continuous loads.

C. Accessories:
1. Cover Mounted Pilot Devices: NEMA ICS 5.
2. Selector Switch: ON/OFF/AUTOMATIC function, with rotary action.
3. Auxiliary Contacts: one normally open and one normally closed in addition to seal-in contact.
4. Relays: NEMA ICS 2,
5. Control Power Transformers: 120-volt secondary, VA as required, in each enclosed contactor. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.

D. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

2.5 RELAYS

A. Manufacturers:
1. Allen Bradley
2. Automatic Switch Co.
3. Eaton
4. ABB
5. Siemens
6. Square D
7. Substitutions: With engineer approval.

B. Product Description: Heavy duty, single-coil momentary contact, mechanically held remote control relays, unless noted otherwise
1. Contacts: Rated 20 amperes at 120-277 volts. Lower ratings may be used for control circuits with approval.
2. Line Voltage Connections: Clamp type screw terminals.

C. Time Delay: Provide where required and/or noted
1. Solid state timer attachment
2. Adjustable from 0.2 to 60 seconds (min). Note that longer time ranges may be specified on plans.
3. Field convertible from ON delay to OFF delay.

D. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

## 2.6 PHASE MONITOR RELAY

A. Manufacturers:
1. ABB
2. Eaton
3. General Electric
4. Siemens
5. Square D
6. Substitutions: With engineer approval.

B. Product Description:
1. Capable of protecting any sized motor
2. Universal operating voltage and frequency. 120 to 480V, 50 or 60 Hz
3. DPDT Isolated 10A output relay contacts
4. Restart delay
5. Wall or din rail mountable
6. Adjustable time delay

C. Protection Requirements
1. Phase Loss (single phasing)
2. Phase reversal
3. Under-voltage, Over-voltage, and Unbalanced Voltage
4. Under-frequency and Over-frequency

D. Relay and control circuit design shall prohibit motor starting throughout the duration of the fault.

## 2.7 PUSH BUTTONS AND SELECTOR SWITCHES

A. Manufacturers:
1. Allen Bradley
2. Eaton
3. ABB
4. Siemens
5. Square D
6. Substitutions: With engineer approval.

B. Product Description: Heavy duty, oil tight, unless noted otherwise
1. Contacts: Rated 20 amperes at 120-277 volts. Lower ratings may be used for control circuits with approval.
2. Line Voltage Connections: Clamp type screw terminals.
3. Indicator lights: LED type, push to test.
4. Provide black ON or START pushbuttons and switches.
5. Provide red OFF or STOP pushbuttons and switches.
6. Provide engraved plastic label.
7. Provide lock out provisions, shrouds, and manual reset functions as noted on plans.

C. Enclosure: Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
   1. Interior Dry Locations: Type 13.
   2. Exterior Locations: Type 3R. Provide 4X for corrosive locations.
   3. Hazardous Locations: UL listed for the space classification, division, group.

## 2.8 GENERAL REQUIREMENTS

A. Equipment to be installed outdoors, in corrosive or hazardous environments shall be rated for the intended use.

B. Compliance with the requirements of the contract documents shall not relieve the contractor of the responsibility of providing equipment that is new, properly designed, from a reputable manufacturer, and in full working order.

C. If conflicts occur between the specifications and drawings, the higher quality, price or quantity shall be provided and installed.

D. If there is any question as to quality, size or quantity necessary, the contractor shall provide a written request for clarification from the Engineer. Contractor shall be responsible for any additional expenses incurred as a result of the contractor's failure to obtain clarification.

E. Detailed product specifications are included in other specification section and on the plans.

# PART 3 EXECUTION

## 3.1 FIELD APPLIED PAINTING

A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

## 3.2 FIELD PROGRAMMING

A. Electrical contractor shall be responsible for the coordination and payment of programming for all programmable devices and equipment including, but not limited to, all power meters and meter monitoring work stations and meter to BAS interfaces, lighting controls, circuit breakers, interfaces with building automation system, power monitoring equipment, etc.

B. Where required, the manufacturer of the product shall be engaged to perform the programming.

## 3.3 EXAMINATION

A. If a conflict is found between the specification and plans, notify the Architect or Engineer of the conflict.

B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

C. Verify existing conditions are as shown on the plans and that adequate space is available for the equipment for installation.

3.4 INSTALLATION

A. The installation requirements shown here are general scope requirements. More detailed information is provided for each of these topics in other specifications and on the plans.
   1. All requirements of the NEC and grounding specifications shall apply to the products specified here.

B. In addition to the applicable installation requirements of the other specification sections and the plans, install all equipment covered under this specification per the following requirements.
   1. Install devices plumb and level.
   2. Secure to structure and support following all requirements of the NEC, other codes, and the AHJ.
   3. Install per manufacturer's recommendations and instructions.
   4. Follow all owner requirements, specifications, and design standards.
   5. Test and

C. Identification
   1. Provide appropriate labels for all equipment, wiring devices, conductors, cables, box, and enclosures
   2. Provide warning signs for electrical equipment and buried circuits.

3.5 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

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# SECTION 26 05 19 - CONDUCTORS AND CABLES 600V OR LESS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes building
   1. wire and cable
   2. service entrance cable
   3. metal clad cable
   4. armored cable
   5. wiring connectors and connections.

### 1.2 REFERENCES

A. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.
   2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

C. Underwriters Laboratories, Inc.:
   1. UL 1277 - Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

### 1.3 SUBMITTALS

A. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
   1. Include amperage and voltage ratings.
   2. Where multiple sizes are listed, indicate sizes to be used.
   3. Where multiple products are shown on the same page, indicate which products to be used.

B. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors.

### 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and circuits.

B. Field Quality-Control Test Reports: Report certified by field testing agent indicating results of performance testing required in Part 3 and/or on plans.
   1. Torque log
   2. Insulation test results

1.5 QUALIFICATIONS

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

B. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.6 QUALITY ASSURANCE

A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.

B. Perform Work in accordance with all applicable city, state, and federal requirements.

C. Maintain one copy of each document on site.

D. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.

E. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

1.7 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on Drawings.

1.8 COORDINATION

A. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

B. Wire and cable routing indicated is approximate unless dimensioned.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Product Requirements: Provide products as follows:

1. Solid, insulated conductor in raceway for feeders and branch circuits 12 AWG and smaller.
2. Stranded, insulated conductors in raceway for feeders and branch circuits 10 AWG and larger
3. Stranded, insulated conductors for control circuits. Route in raceway, except were otherwise allowed to be run exposed in plenum, in tray, etc.
4. Conductor not smaller than 12 AWG for power and lighting circuits.
5. Conductor not smaller than 14 AWG for control circuits.
6. Increase wire size in branch circuits to limit voltage drop to a maximum of 3 percent.

B. Wiring Methods: Provide the following wiring methods:
1. Concealed and Exposed Dry, Wet, or Damp Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
2. Exterior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
3. Underground Locations: Use only building wire, Type XHHW insulation, in raceway.
4. Cable Tray Locations: Use only Tray cable Type TC.

2.2 Conductor Material:

A. Conductor sizes identified by a conductor size of less than 2/0, must use Copper material. Conductor sizes identified a conductor size of 2/0 larger may be Copper or Aluminum material unless type of conductor materials is specifically indicated, or specified, or required by equipment manufacturer.

B. Conductor sizes identified by gauge size (AWG or kcmil) on documents without a conductor material being stated, then the size is based on copper, unless indicated otherwise. Aluminum conductors of equal amperage may be utilized if equivalent amperage is listed in the Feeder Schedule on the drawings.

C. Aluminum Conductors:
1. Aluminum conductors shall be AA-8000 Series electrical grade aluminum alloy conductor material recognized by The Aluminum Association.
2. If aluminum conductors are used the Contractor shall be responsible for increasing conduit and pull box sizes to accommodate larger size aluminum conductors in accordance with NFPA 70; ensuring that pulling tension rating of aluminum conductor is sufficient; providing panelboards and motor control centers that are UL listed for use with aluminum, and so labeled; relocating equipment, modifying equipment terminations, resizing equipment; and resolving problems that are direct results of providing aluminum conductors in lieu of copper. See Feeder Schedule on the single line diagram drawings.

D. Equipment Manufacturer Requirements:
1. When manufacturer’s equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer’s requirements.

2.3 BUILDING WIRE

A. Product Description: Single conductor insulated wire.
1. Conductor: Soft drawn copper, 98% conductivity.
2. Insulation Voltage Rating: 600 volts.

3. Insulation Temperature Rating: 90 degrees C.
4. Insulation Material: Thermoplastic. Type THHN/THWN U.N.O. Use XHHW where install in conduit underground.

B. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by the NEC. Conductors intended as a neutral shall be colored solid white, or identified as required by the NEC. All motor or equipment power wiring shall be colored according to Section 26 05 53, Electrical Identification.

## 2.4 ARMORED CABLE

A. Manufacturers:
1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Substitutions: With engineer approval.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 75 or 90 degrees C.

E. Insulation Material: Thermoplastic.

F. Armor Material: Steel.

G. Armor Design: Interlocked metal tape [Corrugated tube].

## 2.5 METAL CLAD CABLE

A. Manufacturers:
1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Substitutions: With engineer approval.

B. Product Description:
1. Conductor: Soft drawn copper, 98% conductivity.
2. Insulation Voltage Rating: 600 volts.
3. Insulation Temperature Rating: 90 degrees C.
4. Insulation Material: Thermoplastic. Type THHN/THWN U.N.O. Use XHHW where install in conduit underground.

C. Armor Material: Steel.

D. Armor Design: Interlocked metal tape

E. Jacket: Where required.

2.6 WIRING CONNECTORS

A. Provide factory-fabricated, metal connectors of the size, rating, material, type and class as required by manufacturer of the equipment and the NEC. The following types, classes, kinds and styles should be used only where appropriate and as noted
   1. Solderless Pressure Connectors
   2. Crimp
   3. Threaded
   4. Insulated Spring Wire Connectors with plastic caps for 10 AWG and smaller
   5. Split bolt parallel connectors
   6. Pre-insulated multi-tap connectors
   7. Epoxy resin type splicing kits.

B. Wiring connectors shall be insulated to 600V. Conducting components shall match conducting material of wiring (copper, unless noted otherwise).

2.7 TERMINATIONS

A. Terminal Lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.

B. Lugs for Wires 4 AWG and Larger: mechanical lugs

C. Control wiring: Use insulated terminals for control wiring. Use flange spade compression terminal for termination of stranded conductors at wiring devices, including grounding connections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify interior of building has been protected from weather.

B. Verify mechanical work likely to damage wire and cable has been completed.

C. Verify raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

B. Clean conductor surfaces before installing lugs and connectors.

3.3 EXISTING WORK

A. Remove exposed abandoned wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.

B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.

C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.

D. Extend existing circuits using materials and methods compatible with existing electrical installations, or as specified.

E. Clean and repair existing wire and cable remaining or wire and cable to be reinstalled.

3.4 INSTALLATION

A. Neatly train and lace wiring inside boxes, equipment, and panelboards.

B. Install electrical cable, wire and connectors as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and as required to ensure that products serve the intended functions.

C. Wiring Installation in Raceways
1. Wire and cable shall be pulled into clean dry conduit. Do not exceed manufacturer's recommended values for maximum pulling tension.
2. Do not install the conductors until the raceway system is complete and properly cleaned.
3. Pull conductors together where more than one is being installed in a raceway.
4. Use UL listed pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.
5. Do not use a pulling means, including fish tape, cable or rope, which can damage the raceway.
6. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
7. Place an equal number of conductors for each phase of a circuit in same raceway.
8. Provide separate conduit or raceway for line and load conductors of motor starters, safety disconnect switches, and similar devices. Those devices shall not share the same raceway.
9. All conduits shall contain a green grounding conductor. Conduit, wireways, or boxes shall not be used as the equipment grounding conductor.

D. Cable :
1. Protect exposed cable from damage.
2. Support cables above accessible ceiling, using spring metal clips or appropriate cable ties to support cables from structure. Do not rest cable on ceiling panels.
3. Use suitable cable fittings and connectors.

E. Metal Clad and Metal Armored Cable
1. Metal clad cable shall not be used for homeruns or in exposed locations. Use shall be restricted to locations and conditions explicitly allowed by these specifications and the owner's design guidelines.
2. MC and or AC cable may be used after the first device, or after a junction box located in accessible ceiling space above first wiring device on a 20A circuit where concealed.

3. All switch boxes shall be provided with conduit to junction box above accessible ceiling to allow for future modification.
4. MC cable shall not be used for connections to dedicated receptacles or pieces of equipment.

F. Wiring Connections and Terminations
1. Install splices, taps and terminations, which have equivalent-or-better mechanical strength and insulation as the conductor. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
2. Keep conductor splices and taps accessible and to a minimum. Splice branch circuits only in accessible junction or outlet boxes. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundles connections, minimum 5 feet at each location, unless noted otherwise on drawings.
3. Splices below grade shall only be in handholes or manholes and shall be made watertight with epoxy resin type splicing kits similar to Scotchcast. 20A branch circuit splices installed below grade may use scotch-lock or other means of making water resistant.
4. Use splice, tap and termination connectors, which are compatible with the conductor material.
5. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
6. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor and label as spare.
7. Power and Lighting Circuits:
   a. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger.
   b. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits.
   c. Use split bolt connectors for copper wire splices and taps, 6 AWG and larger.
8. Controls Circuits
   a. Control circuit conductors shall terminate at terminal blocks only. Control cable shall never be spliced except the final connection to field devices.
   b. If stranded conductors used for #10 or smaller for controls, FA, security, etc, install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.
9. Connections for all wire sizes in motor terminal boxes where the motor leads are furnished with crimped-on lugs shall be made by installing ring type compression terminals on the motor branch circuit ends and then bolting the proper pairs of lugs together. First one layer of No. 33 scotch tape reversed (sticky side out), then a layer of rubber tape, then two layers of No. 33 half-lapped.
10. Terminate aluminum conductors with tin-plated, aluminum-bodied compression connectors only. Fill with anti-oxidant compound before installing conductor.
11. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

G. Terminal Lugs
1. Install terminal lugs on ends of 600 volt wires unless lugs are furnished on connected device, such as circuit breakers.
2. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.

3. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

H. Voltage Drop
1. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of "home runs" over 50' length (100' for 277 volt) no conductor smaller than a No. 10 wire shall be used.
2. Voltage drop on feeders and branch circuits shall not exceed NEC requirement.
3. Voltage drop on control circuits shall not exceed the requirements of the equipment that the wiring serves.

I. Control Wiring

J. Run in separate conduits from building wiring.

K. Departures from the sizes specified in Part 2 shall be made only in those cases in which the National Electrical Code requires the use of larger conductors.

L. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown.

M. Wiring Within an Enclosure:

N. Contractor shall bundle AC and DC wiring separately within an enclosure.

O. The Contractor shall utilize panel wire-ways when they are provided.

P. Where wireways are not provided, the Contractor shall neatly tag and bundle wires and secure to sub-panel at a minimum of every three inches.

Q. Separate neutral conductors shall be provided for each single-phase circuit.

R. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundles connections, minimum 5 feet at each location, unless noted otherwise on drawings.

S. Do not band any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors.

## 3.5 WIRE COLOR

A. General:
1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following for each phase A, B, C, and Neutral:
   a. Black (A), Red (B) for single phase circuits at 120/240 volts
   b. Black (A), Red (B), Blue (C) for circuits at 120/208 volts single or three phase.
   c. Brown (A), Orange (B), Yellow (C) for circuits at 277/480 volts single or three phase.
2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Use colors listed above.

B. Neutral Conductors: White. Use gray for 277/480V neutrals were required by AHJ. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.

D. Feeder Circuit Conductors: Uniquely color code each phase.

E. Ground Conductors:
   1. For 6 AWG and smaller: Green.
   2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

## 3.6 FIELD QUALITY CONTROL

A. Before final acceptance, the Contractor shall make voltage, insulation, and load tests, necessary to demonstrate to the Owner's representative the satisfactory installation and proper performance of all circuits.

B. All terminations rated 60A or larger shall be made using a torque wrench and the results recorded in a log to be provided to owner with closeout documents.

C. Test feeder conductor insulation. Insulation-resistance test shall be conducted per NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
   1. Test results below 50 megohms shall be cause for rejection of the wiring installation.
   2. Replace and retest all non-compliant conductors.
   3. Provide written log of testing results to owner with closeout documents.

## 3.7 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

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# SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## 1.1 SUMMARY

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

B. Section Includes:
1. Rod electrodes.
2. Wire.
3. Mechanical connectors.
4. Exothermic connections.

## 1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.
2. NFPA 99 - Standard for Health Care Facilities.

## 1.3 SUBMITTALS

A. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
1. Include amperage ratings, voltage, over-current protective device ratings, AIC ratings.
2. Where multiple sizes are listed, indicate sizes to be used.
3. Where multiple products are shown on the same page, indicate which products to be used.

B. Manufacturer's Installation Instructions: Submit for active electrodes.

C. Manufacturer's Certificate: Certify, Products meet or exceed specified requirements.

## 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and grounding electrodes.

B. Field Quality-Control Test Reports: Report certified by field testing agent indicating results of performance testing required in Part 3 and/or on plans.: Indicate overall resistance to ground.

1.5 QUALIFICATIONS

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

B. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.6 QUALITY ASSURANCE

A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.

B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

C. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.

D. Maintain one copy of each document on site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, chemical and mechanical damage, freeze, and where applicable, deterioration from sun light. Store in original packaging where possible.

C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.8 COORDINATION

A. Complete grounding and bonding of building reinforcing steel prior to concrete placement.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

A. Product Description:
   1. Material: Copper.
   2. Diameter: 5/8 inch.
   3. Length: 10 feet.

B. Connector: Connector for exothermic welded connection.

2.2 GROUNDING AND BONDING WIRE

A. Material:
1. Match building wiring material specifications
2. Except where noted bare, match building wiring insulation.
3. Minimum requirement: 600V, stranded copper.
4. Solid copper may be used for #8 AWG and smaller.

B. Foundation Electrodes: 4 AWG bare, strand copper.

C. Grounding Electrode Conductor: stranded Copper conductor bare.

D. Grounding Straps: Tin plated copper braided cable, 1" thick x 0.1" thick (min), #1 awg, with ¾" one hole connections on both ends (note: other connection types may be noted on plans)

2.3 MECHANICAL CONNECTORS

A. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

B. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

2.4 EXOTHERMIC CONNECTIONS

A. Product Description: Exothermic welding kits, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.5 GROUND BUS

A. Rectangular bars of annealed copper, 12-inch-long, ¼" by 2" in cross section, unless otherwise indicated.

B. Provide with manufacturer's insulators to stand ground bus off mounting surface.

C. Requirements for electrical switchgear, switchboards, distribution and branch circuit panel ground buses are covered by the specification section that cover said equipment.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

A. Remove paint, rust, mill oils and surface contaminants at connection points.

3.3 SERVICE ENTRANCE GROUNDING ELECTRODE SYSTEM

A. Install grounding electrode system as required by NEC. At a minimum, a grounding electrode conductors shall be extended to:
   1. The building metal cold water piping, bolted connection.
   2. Structural steel framing, welded connection.
   3. 20 ft. of bare copper encased in concrete, Ufer ground.
   4. 20ft of bare copper conductor buried at 24” or driven ground rods.
   5. Additional electrodes as required to achieve minimum ground impedance as specified below.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
   2. Install grounding well pipe with cover at rod locations as indicated on Drawings. Install well pipe top flush with finished grade.

C. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor sized per plans but not smaller than No. 4 AWG
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

D. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building’s main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically by pass water meters. Connect pipe with a bolted connector.
   3. Bond each above ground portion of gas piping system downstream from equipment shutoff valve.

E. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.

F. Install grounding electrode conductor and connect to reinforcing steel in foundation footing.

G. Additional grounding electrode requirements and grounding electrode conductor sizes are shown on the plans.

## 3.4 INSTALLATION

A. General Requirements
1. Install in accordance with IEEE 142, NEC requirements, and manufacturer's recommendations.
2. Install grounding and bonding conductors concealed from view.
3. Routing of grounding electrode, special systems ground conductors, and other grounds not routed in feeders or branch circuit raceways shall be installed in a dedicated metal conduit in all locations subject to physical abuse or environmental deterioration such as exterior mounted, exposed below ceiling, etc.
4. Ground system using separate insulated grounding conductor installed with every feeder and branch circuit conductors in conduits. Terminate each end on suitable lug, bus, or bushing.
5. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes, equipment ground terminal, or metal enclosures of equipment.
6. Raceway systems shall be made continuous from source to load.
    a. Provide bonding jumpers were raceway system is inherently discontinuous such as where conduits terminate at cable trays.
    b. Raceway shall be made continuous using mechanical connections that have been securely tightened using the appropriate tool. Hand tight is not acceptable.
7. Permanently attach equipment and grounding conductors prior to energizing equipment.
8. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors
9. Provide grounding bushings for conduit terminations at panels, electrical equipment, enclosures, etc.

B. Bonding Straps and Jumpers:
1. Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
2. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
3. Bonding to Equipment Mounted on Vibrations Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
4. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
5. Bond the following components to the grounding electrode
    a. System neutral at service entrance and transformer secondaries
    b. Service equipment enclosures, exposed non-current carrying metal parts of electrical equipment
    c. Metal raceway systems, cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath
    d. Ground bus in electrical rooms and IT rooms
    e. Lightning protection system. Refer to Section 26 41 00.
    f. Metal siding not attached to grounded structure; bond to ground.

C. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors

4. Connections to structural Steel: Welded connectors.

3.5 FIELD QUALITY CONTROL

A. Grounding System Resistance: 5 ohms maximum.

B. Perform ground resistance testing
   1. Test in accordance with IEEE 142.
   2. Provide additional grounding electrodes as required to achieve resistance listed above.
   3. Testing shall be performed when the soil is dry and there has been no rain in the past 48 hours.

C. Perform leakage current tests in accordance with NFPA 99.

D. Perform continuity testing in accordance with IEEE 142.

E. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

3.6 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

# SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Conduit supports.
2. Formed steel channel.
3. Spring steel clips.
4. Equipment bases and supports.

### 1.2 REFERENCES

A. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

B. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.

C. Underwriters Laboratories Inc.:

D. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

### 1.3 SUBMITTALS

A. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

B. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.

### 1.4 QUALIFICATIONS

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

B. Supplier: Authorized distributor

C. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.5 QUALITY ASSURANCE

A. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.

B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

A. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

B. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

C. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt and nut to tighten.

D. Conduit straps - general purpose:
1. One hole zinc plated steel for surface mounted conduits 1” or less.
2. Two hole zinc plated steel for surface mounted conduits greater than 1”

2.2 CABLE TIES

A. High strength nylon temperature rated to 185 degrees F.

B. Self-Locking

2.3 FORMED STEEL CHANNEL

A. Product Description:
1. Galvanized 12 gage thick steel.
2. Holes 1-1/2 to 2 inches on center.
3. Provide angle brackets and other accessories from the same manufacture and from the same materials with the same finish

B. Provide heavier gage channel where the weight of the equipment exceeds the ratings of the products specified above.

C. Steel Pipe Straps
   1. Provide straps from the same manufacturer and of the same material and finish as channel
   2. Bolt head combination slot and hex head with square nut
   3. Conduit size engraved in strap for easy identifications
   4. Design load of 500lbs min.

2.4 SPRING STEEL CLIPS

A. Product Description: Mounting hole and screw closure.

2.5 BOX SUPPORTS

A. Outlet boxes
   1. Provide between stud box mounting brackets secured to the two adjacent studs.
   2. Provide two self-tapping screws on each side to secure bracket to stud
   3. Where two studs are not available, provide far side box support strap

B. Pull and Junction boxes
   1. Provide threaded hangers and channel supports for pull and junction boxes suspended from ceiling

PART 3 EXECUTION

3.1 PREPARATION

A. Remove incompatible materials affecting bond.

B. Obtain permission from Architect/Engineer before using powder-actuated anchors.

C. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.2 INSTALLATION - HANGERS AND SUPPORTS

A. General Requirements
   1. Support raceways using galvanized steel or malleable iron straps, channel, and/or beam/pipe clamps as appropriate.
   2. Install conduit and raceway support and spacing in accordance with NEC.
      a. Provide supports at all boxes, elect equipment, and loads
      b. Provide supports at code required intervals along raceways.
   3. Support independent of other systems. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
   4. Install multiple conduit runs on common hangers. Provide spare capacity on support elements where more than three conduits are grouped together.

B. Anchors and Fasteners:
   1. Concrete Structural Elements: Provide precast inserts, expansion anchors and preset inserts.
   2. Steel Structural Elements: Provide beam clamps, spring steel clips, and welded fasteners.
   3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.

4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
6. Sheet Metal: Provide sheet metal screws.
7. Wood Elements: Provide wood screws.

C. Inserts:
1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut.

D. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
2. Install surface mounted boxes, cabinets, and panelboards with minimum of four anchors.
3. Install surface mounted device boxes with a minimum of two anchors, secure boxes in stud walls to the studs on both sides of the box
4. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
5. Support vertical conduit at every floor.

## 3.3 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of 3000 PSI concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.

## 3.4 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

## 3.5 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

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# SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes:
1. Conduit and tubing
2. Surface raceways
3. Wireways
4. Outlet boxes
5. Pull and junction boxes
6. Enclosures and Cabinets

C. Related Sections:
1. The requirements of this specification shall be followed when installing raceway for all mechanical, controls, electrical, and special systems work covered by other specifications.

### 1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).

B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

C. Underwriters Laboratories Inc.:
1. Products shall be listed where required by the NEC
2. Fire-stopping products shall be listed.

### 1.3 SUBMITTALS

A. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, and clearly indicating which optional features will be provided for the following items:

1. Metal conduit
2. Flexible metal conduit.
3. Liquidtight flexible metal conduit.
4. Nonmetallic conduit.
5. Raceway fittings and supports.
6. Conduit bodies.
7. Surface raceway.
8. Wireway.
9. Pull and junction boxes.
10. Enclosures and cabinets
11. Handholes.

B. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents:
1. Record actual routing of conduits larger than 2 inches.
2. Record actual locations and mounting heights of outlet, pull, and junction boxes larger than 4x4.

1.5 COORDINATION

A. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.

B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

1.6 QUALIFICATIONS

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

B. Installer: A state licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications, required by core, or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.7 QUALITY ASSURANCE

A. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

B. Fire Rated Assemblies: Tested and listed per all requirements of ASTM and UL to achieve the fire-resistant rating of the wall (1 hour minimum). Refer to architectural plans for all locations of fire rated floor, roof, and wall assemblies.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Subject to the requirements of the specifications, products by the following manufacturers may be used for raceways and boxes. UL listed substitutions that are compliant with these specifications are acceptable provided compliance with all specification requirements are clearly indicated on the submittal.
1. Apleton
2. Carlon Electrical Products
3. Hubbell Wiring Devices
4. Thomas & Betts Corp.
5. Walker Systems Inc.
6. The Wiremold Co.
7. Wheatland Tube Company
8. Allied Tube & Conduit
9. B I A
10. Cantex
11. Southwire
12. Eastern
13. Pass & Seymour
14. Hoffman

2.2 SYSTEM DESCRIPTION

A. Where noted, provide raceway and boxes as specified below for power, lighting, communications, fire alarm, access control/security, controls, and other special systems.
1. Provide raceway and boxes for all building wiring, equipment; lighting; wiring devices; communications equipment and outlets; fire alarm equipment, appliances, and devices; access control/security points; controls points; and other special systems shown on plans.
2. Provide raceway and boxes at other locations as required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground:
   1. Provide wrapped rigid steel conduit for 1" or larger elbows and where entering and exiting slabs or ground.
   2. Provide thick-wall nonmetallic conduit for straight runs that are buried and/or in concrete.
   3. Provide high-grade plastic boxes or polymer concrete boxes. Coordinate with engineer.
   4. Provide boxes for utility service conduit or cabling per utility provider's specifications
   5. Nonmetallic hand-holes may be used for site lighting and controls circuits
   6. Provide rigid steel conduit within 5 ft. of building foundation.

C. In Concrete:
   1. Provide wrapped rigid steel conduit for 1" or larger elbows and where entering or exiting concrete.
   2. Provide Schedule 40 nonmetallic conduit for straight runs in concrete.
   3. Provide high-grade plastic boxes or polymer concrete boxes. Nonmetallic may be used with engineer approval.
   4. Use concrete tight, masonry rated boxes and fittings were installed in concrete, stone, brick, or CMU.

D. Exterior Above Grade and Wet/Damp Interior Locations:
   1. Provide Schedule 80 non-metallic conduit or rigid steel conduit and fittings.
   2. Provide non-metallic or cast metal outlet, junction, and pull boxes, gasketed, rated NEMA 3R min.

E. Concealed Dry Interior Locations with Raceways:
   1. Provide Schedule 40 non-metallic conduit, rigid steel conduit, intermediate metal conduit, or electrical metallic tubing.
   2. Provide non-metallic or sheet-metal boxes.

F. Exposed Dry Interior Locations:
   1. Provide Schedule 80 PVC or rigid steel conduit below 10 feet, rigid steel, intermediate metal, or electrical metallic tubing above 10 feet.
   2. Provide non-metallic or sheet-metal boxes.

G. Corrosive Environments
   1. Provide RGS conduit. PVC may be used where allowed by code, protected, and approved by engineer.
   2. Provide NEMA 4X enclosures.
   3. Corrosive Environments shall include all interior locations and exterior within 50 feet of locations where liquid or gaseous corrosive materials are used or stored.

H. Hazardous (Classified) Locations
   1. Provide threaded conduits and fittings, properly sealed.
   2. Provide explosion proof enclosures where required.
   3. Hazardous Locations include areas that should be considered Class 1, 2, or 3 Locations as defined by NEC Chapter 5.

## 2.3 METAL CONDUIT

A. Rigid Steel Conduit:

1. ANSI C80.1.
2. Material: galvanized tubing, manufactured from mild steel.
3. Continuously welded seems.
4. Uniform wall thickness and cross section.
5. Manufacturer applied lubricating and corrosion retarding coating applied to interior of conduit.
6. The minimum conduit size is 3/4", except fixture whips may be ½".

B. Rigid Aluminum Conduit:
1. ANSI C80.5.
2. Continuously welded seems
3. Uniform wall thickness and cross section

C. Intermediate Metal Conduit (IMC): Rigid steel.

D. Fittings and Conduit Bodies:
1. NEMA FB 1
2. Material to match conduit.
3. Couplings and connectors: threaded
4. Expansion Fittings: OZ Type DX, concrete tight, provide for ¾" movement in all directions and/or 30 degrees deflection in any direction

## 2.4 PVC COATED METAL CONDUIT

A. Product Description: NEMA RN 1; rigid steel conduit with external PVC coating, 20 mil thick.

B. Fittings and Conduit Bodies: NEMA FB 1; steel fittings with external PVC coating to match conduit.

## 2.5 FLEXIBLE METAL CONDUIT

A. Product Description: Interlocked steel construction.

B. Fittings: NEMA FB 1.

C. FMC shall be used in the following locations
1. For lighting whips
2. For connections to vibrating equipment
3. In applications where rigid conduit cannot be installed without extensive demolition, but only with engineer's approval.

## 2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Product Description: Interlocked steel construction with PVC jacket.

B. Fittings: NEMA FB 1.

C. Use LFMC for all exterior vibrating equipment loads and in pump rooms that contain large quantities of mechanical and plumbing piping in the vicinity of the flex conduit.

2.7 ELECTRICAL METALLIC TUBING (EMT)

A. Product Description:
1. ANSI C80.3
2. Material: galvanized tubing, manufactured from mild steel
3. Continuously welded seems
4. Uniform wall thickness and cross section
5. Manufacturer applied lubricating and corrosion retarding coating applied to interior of conduit
6. The minimum conduit size is 3/4", except fixture whips may be ½".

B. Fittings and Conduit Bodies:
1. NEMA FB 1
2. Material: zinc plated steel
3. Concrete tight
4. Connectors and couplings: **compression type**.
5. Expansion Fittings: OZ Type TX

2.8 NONMETALLIC CONDUIT

A. Product Description: NEMA TC 2; Schedule 40 and 80 PVC.
1. Schedule 40 PVC may be used where buried or embedded.
2. Use schedule 80 PVC conduit for any exposed exterior or interior applications requiring corrosive resistant PVC conduit such as pool pump rooms.
3. The minimum conduit size is ¾".
4. 1" shall be used for underground conduit runs longer than 50ft.

B. Fittings and Conduit Bodies: NEMA TC 3.

2.9 NONMETALLIC TUBING

A. Product Description: NEMA TC 2.

B. Fittings and Conduit Bodies: NEMA TC 3.

2.10 SURFACE METAL RACEWAY

A. Surface metal raceway shall be factory pre-assembled galvanized steel complete including bases, removable covers, receptacles, end plates, elbows, connectors and fittings.

B. Size shall be as shown on the Drawings.
1. The length shown on electrical drawings is diagrammatic only and is not accurate for fabrication of raceway Sections.
2. Refer to architectural plans and elevations for furniture and casework details and size to match the length of the furniture, cabinets, casework, work benches, and/or shelving at which the raceway will be installed.
3. Coordinate with owner and general contractor to verify that raceway lengths match furniture, casework, and/or laboratory shop drawings before ordering.

C. Finish shall be ANSI-61 gray enamel

D. Covers shall be field removable by use of a standard screwdriver, without marring the extrusion or cover finish. Raceway with two covers must allow each cover to be removed separately without access into the compartment(s) enclosed by the other cover.

E. Provide a permanent, integral, grounded metallic dividing barrier to isolate the wiring compartments in the multi-outlet raceway system where raceway is used for power and communications. Provide divider with fittings that maintain the separation of the raceway wiring compartments.

F. Provide device brackets for mounting standard single-gang or two-gang devices within the raceway system. Devices shall have the capacity of mounting flush or in conjunction with device faceplates

G. Provide receptacles for the respective power systems as indicated on the drawings. Receptacles shall meet the requirements of the Wiring Devices specifications.

2.11 SURFACE NONMETAL RACEWAY

A. Product Description: Plastic or fiberglass channel with fitted cover, suitable for use as surface raceway.

B. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories, finish to match raceway.

C. Covers shall be field removable by use of a standard screwdriver, without marring the extrusion or cover finish. Raceway with two covers must allow each cover to be removed separately without access into the compartment(s) enclosed by the other cover.

D. Provide a permanent, integral, grounded metallic dividing barrier to isolate the wiring compartments in the multi-outlet raceway system where raceway is used for power and communications. Provide divider with fittings that maintain the separation of the raceway wiring compartments.

E. Provide device brackets for mounting standard single-gang or two-gang devices within the raceway system. Devices shall have the capacity of mounting flush or in conjunction with device faceplates

F. Provide receptacles for the respective power systems as indicated on the drawings. Receptacles shall meet the requirements of the Wiring Devices specifications.

2.12 WIREWAY

A. Wireways shall be of steel construction general purpose for indoor spaces and rain tight for outdoor applications with knockouts.

B. Knockouts: Manufacturer's standard.

C. Size: as indicated on Drawings.

D. Cover: Hinged cover with full gaskets.

E. Fittings: Lay-in type with removable top, bottom, and side; captive screws.

F. Finish: Rust inhibiting primer coating with gray enamel finish.

## 2.13 OUTLET BOXES

A. Sheet Metal Outlet Boxes:
   1. NEMA OS 1
   2. Material: galvanized steel.
   3. 4”x4”, 2” deep, unless noted otherwise
   4. Concentric knockouts
   5. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2-inch male fixture studs where required.
   6. Concrete Ceiling Boxes: Concrete type.

B. Nonmetallic Outlet Boxes: NEMA OS 2.

C. Cast Boxes: NEMA FB 1, Type FD, aluminum or cast feralloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.

D. Wall Plates for Finished Areas: As specified in Section 26 27 26.

E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

F. Outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, mud rings extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

G. Provide multi-gang outlets of single box design. Sectional boxes are not acceptable. Provide outlet boxes of sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NEC, and not less than 1-1/2-inch-deep unless shallower boxes are required by structural conditions and are approved by the A/E.

H. Provide deep type cast metal weatherproof exterior outlet wiring boxes of the type, shape and size, including depth of box, with threaded conduit ends, cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate gasket and fasteners. Provide PVC type outlet boxes only in corrosive areas rated as NEMA 4X.

## 2.14 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel. Screw on cover, welded seams, stainless nuts, bolts, screws and washers.
   1. Boxes larger than 12 inches in any dimension shall be panelboard code gauze galvanized steel with hinged cover.
   2. Boxes shall be sized in accordance with NEC.

B. Hinged Enclosures: Provide hinged covers for enclosures larger than 4”. Coordinate with engineer if screw type covers must be used for any reason.

C. Surface Mounted Cast Metal Box: NEMA 250, Type 4X; flat-flanged, surface mounted junction box:
   1. Material: Galvanized cast iron. Cast aluminum may be used with engineer approval

2. Cover: Furnish with ground flange, neoprene gasket, and stainless-steel cover screws.

D. In-Ground Cast Metal Box: NEMA 250, Type 6, outside or inside flanged as required by site conditions, recessed cover box for flush mounting:
1. Material: Galvanized cast iron. Cast aluminum may be used with engineer approval
2. Provide box with a bottom with drain and a min 12”x12” gravel sump below drain opening.
3. Cover: Nonskid cover with neoprene gasket and stainless-steel cover screws.
4. Cover Legend: "ELECTRIC” or “COMMUNICATIONS
5. Box shall be traffic rated unless located in a position that is physically inaccessible to vehicular traffic.

E. In-Ground Polymer Concrete Boxes
1. Selectively graded aggregates in combination with a polymer resin reinforced with fiberglass
2. Provide a bottom with drain and a min 12”x12” gravel sump below drain opening.
3. Conform to all test provisions of the most current ANSI/SCTE 77 specifications for underground enclosure integrity.
4. Cover: Nonskid cover with neoprene gasket and stainless-steel cover screws.
5. Cover Legend: "ELECTRIC” or “COMMUNICATIONS
6. Box shall be traffic rated unless located in a position that is physically inaccessible to vehicular traffic.

F. Fiberglass Concrete composite Handholes: Die-molded, glass-fiber hand holes:
1. 12”x8” min dimensions.
2. Cover: Glass-fiber concrete composite, weatherproof cover with nonskid finish.
3. Use only where specifically noted as allowed.

## 2.15 ENCLOSURES AND CABINETS

A. Construction: NEMA 250, Type 1 steel enclosure.
1. Use NEMA 3R in wet locations
2. Use NEMA 4X in corrosive locations.

B. Covers: Continuous hinge, held closed by flush latch operable by key

C. Furnish interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.

D. Provide wire management systems, terminal strips, and partitions as required for complete functioning of the system.

E. Enclosure Finish: Manufacturer's standard enamel

## 2.16 SLEEVES

A. Materials:
1. Interior Locations: Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends

2. Exterior Wall Penetrations: Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated
3. Fire Rated and Fire Resistive Floors and Walls: Prefabricated fire rated sleeves including seals, UL listed

B. Sleeves for Rectangular Openings: Galvanized sheet steel.
1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter, less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

C. Waterproof Sleeve Seals
1. Description: Modular mechanical type, designed for field assembly, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. NMP Corporation
   e. Pipeline Seal and Insulator, Inc.
   f. Thunderline Link-Seal, Inc.
3. Sealing Elements: Interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable
4. Pressure Plates: Carbon Steel. Include two for each sealing element.
5. 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.

## 2.17 FIRESTOPPING

A. Manufacturers:
1. Dow Corning Corp.
2. Fire Trak Corp.
3. Hilti Corp.
4. International Protective Coating Corp.
5. 3M fire Protection Products
6. Specified Technology, Inc.
7. Substitutions: With engineer approval.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.

2. Foam Firestopping Compounds: Single component foam compound.
3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.

C. Firestopping Materials: ASTM E119 or EB14 tested and UL Listed to achieve fire ratings of adjacent construction.

D. Conform to applicable code for fire resistance ratings and surface burning characteristics.

E. Color: Red in concealed location, black where exposed and allowed by AHJ.

2.18 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:
1. Mineral fiberboard.
2. Mineral fiber matting.
3. Sheet metal.
4. Plywood or particle board.
5. Alumina silicate fire board.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.

B. Remove concealed abandoned raceway to its source.

C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.

D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.

E. Extend existing raceway and box installations using materials and methods [compatible with existing electrical installations, or] as specified.

F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

A. Provide complete raceway systems from source to all loads with dedicated supports for each raceway element where noted in the drawings.

B. Provide all required back boxes and supports for wiring devices, telecommunications, fire alarm, access control, controls equipment, alarms, sensors, etc.

C. Provide pull box at appropriate locations for all power and special systems raceways whether shown on plans or not.

D. Arrange raceway and boxes to present a neat appearance; allow for future expansion; provide access where needed; and maintain headroom and clearances for equipment, egress, etc.

E. Fasten raceway and box supports to structure and finishes in accordance with all requirements of the NEC and the construction documents.

F. Ground and bond raceway and boxes in accordance with all requirements of the NEC and the construction documents.

G. Identify raceway and boxes in accordance with all requirements of the NEC and the construction documents.

H. Paint exposed raceway and boxes to match the surface to which they are attached to architectural painted surfaces and finished areas.

3.4 INSTALLATION - RACEWAY

A. Raceway Supports
   1. Support raceway using galvanized steel, malleable iron straps, or channel and pipe clamps.
   2. Provide support at each junction box, panel and load.
   3. Provide supports at intervals per code and manufacturer recommendations.

4. Group related raceway and support using steel channel conduit rack. Provide space on each for 25 percent additional raceways.
5. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
6. Do not attach raceway to ceiling support wires or other piping systems such as sprinkler or HVAC piping or duct work.
7. Support cables in vertical raceways per NEC 300.19.
8. Construct wireway supports from steel channel.
9. Arrange raceway supports to prevent misalignment during wiring installation.
10. Additional supporting requirements are specified in other specification sections.

B. Raceway Routing
1. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
2. The conduit routing shown on the construction documents is diagrammatic.
   a. Coordinate interior routing with other trades; structure; existing and new utilities, ductwork, piping; and other existing conditions as required for a complete, conflict free installation.
   b. Coordinate site routing with other trades; structure; new and existing buried utilities, new and existing paved areas, conduit sleeves, and landscaping before digging to avoid conflicts, damage, and to allow for future installations.
3. Route raceway parallel and perpendicular to walls, floors, and ceilings.
4. Route exposed conduit parallel to structural elements. Follow all surface contours; do not route in free air from point to point. Where physically possible, install on top side of structural elements to conceal from view. Paint to match structure to which it is attached.
5. Route conduit in and under slab from point-to-point. Coordinate conduit installations in slab with structural engineer for conduits larger than 2”.
6. Maintain clearance between raceway and piping for maintenance purposes.
7. Maintain 12-inch clearance between power raceways and communications cabling, raceways, and cable trays.
8. Maintain 12-inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
9. Install no more than equivalent of three 90-degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Use factory elbows or hydraulic one-shot bender to fabricate elbows for bends in metal conduit larger than 2-inch size.

C. Install raceways so that it drains to junction and pull boxes to avoid moisture traps at low points; install junction box with drain fitting at low points in conduit system.

D. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.

E. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

F. Close ends and unused openings in surface raceways, wireways, boxes, and enclosures.

G. Maximum Size Conduit in Slab Above Grade: 3/4 inch. Do not cross conduits in slab without approval.

H. Cut conduit square using saw or pipe cutter; de-burr cut ends.

I. Bring conduit to shoulder of fittings; fasten securely.

J. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.

K. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

L. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

M. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

N. All connections to motors, instruments, machines, and equipment subject to movement or vibration shall be made using liquid-tight flexible metal conduit (3ft max).

## 3.5 INSTALLATION – BOXES, ENCLOSURES, CABINETS

A. General Requirements
1. Seal all unused openings.
2. Provide flush mounted boxes in finished areas.
3. Support boxes independently of conduit.
4. Install boxes without damaging or removing insulation, cutting structural elements, or damaging finishes.
5. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

B. Wiring Device Boxes
1. Install gang box where more than one device is mounted together. Do not use sectional box.
2. Install gang box with plaster ring for single device outlets.
3. Adjust mounting locations to be flush with finished surface.
4. Secure boxes using stamped steel bridges between studs.
5. Do not install flush mounting box back-to-back in walls
   a. Install with minimum 6 inches separation.
   b. Install in separate stud bays to reduce noise transfer where ever possible.
   c. Install with minimum 24 inches separation in acoustic rated walls.
6. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings. Refer to architectural elevations for mounting heights of outlet boxes noted “above counter.”
7. Orient boxes to accommodate wiring device orientation. Field verify with architect for wiring devices mounted above counters or exposed to view in lobbies, on display walls, etc.
8. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.

C. Ceiling Mounted Boxes
1. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
2. Install adjustable steel channel fasteners for hung ceiling outlet box.

3. Do not fasten boxes to ceiling support wires or other piping systems.

D. Masonry Walls and Poured In Concrete
1. Install recessed boxes in the corner of masonry blocks so that only the corner of one masonry element is required to be cut.
2. File smooth the edges of cut masonry blocks. Replace cracked or damaged blocks.
3. Seal concrete tight all openings in boxes prior to pouring concrete.
4. Verify box is level and flush with finished grade. File down edges that protrude above finished grade.

## 3.6 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with the fire stopping material manufacturer's instructions.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation. Follow architectural details for any required roof penetrations. Obtain permission from architect for dedicated electrical rough penetrations before performing work.

C. Locate outlet boxes to allow luminaires positioned as indicated on reflected ceiling plan.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

## 3.7 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused openings in boxes.

## 3.8 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

## 3.9 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, floors, ceilings concrete or masonry walls, partition walls in finished exposed spaces, or fire-rated floor and wall assemblies.

B. Sleeve Installations:
1. Position raceway or cable in center of sleeve.
2. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
3. Extend sleeves installed in floors 3 inches above finished floor level.
4. For fire rated penetrations, size sleeve allowing minimum of 1 inch annular clear space between raceway and sleeve.

5. For exterior wall penetrations, size sleeve allowing minimum of 1 inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.
6. For other penetrations, size sleeve allowing ¼ to ½" annular clear space between raceway and sleeve.
7. Where bus, cable bus, conduit, wireway, or trough, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

C. Install escutcheons, floor plates, or ceiling plates where conduit, penetrates surfaces in occupied spaces or exterior walls. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
1. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
2. Install stainless steel escutcheons at finished surfaces.

D. Sealing
1. Exterior wall and other water tight openings: Seal with adjustable, interlocking rubber links of mechanical seal (waterproof sleeve seal) sized to cover annular space between raceway and sleeve. Install in accordance with manufacturer's instructions.
2. Conduit penetrations not required to be watertight: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint
3. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
4. Seal space outside of sleeves with grout for penetrations of concrete and masonry
5. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated (for fire rated walls).
6. Special interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.
7. Hazardous areas: Seal conduits entering areas classified as hazardous per the NEC using explosion proof fittings and sealing materials.

E. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

F. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

G. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

H. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials that meet the fire rating of the wall.

## 3.10 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Install per manufacturer's instruction and in accordance with architectural and owner specifications.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating and uniform density and texture.

D. Compress fibered material to maximum 40 percent of its uncompressed size.

E. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

F. Place intumescent coating in sufficient coats to achieve rating required.

G. Remove dam material after firestopping material has cured.

3.11 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

# SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section Includes:
1. Nameplates.
2. Labels.
3. Wire markers.
4. Conduit markers.
5. Stencils.
6. Underground Warning Tape.
7. Lockout Devices.
8. Operating Instructions
9. Nameplates
10. Warning Signs

### 1.2 SUBMITTALS

A. Product Data:
1. Submit manufacturer’s catalog literature for each product required.
2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

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

### 1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

### 1.4 QUALITY ASSURANCE

A. Perform Work in accordance with federal, state, and local codes

B. Provide all labeling as required by NFPA 70 and 70E.

### 1.5 QUALIFICATIONS

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

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept identification products on site in original containers. Inspect for damage.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.

B. Letter Size:
1. 1/4-inch-high (min) letters for identifying individual equipment and loads.
2. 1/4-inch-high (min) letters for identifying grouped equipment and loads.

C. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

A. Generic Labels: Embossed adhesive tape, with 3/16 inch white letters on black background.

B. Finished area Receptacles Cover Labels: Adhesive labels, clear with black text.

C. Labels for receptacles controlled by motion sensing devices: Embossed adhesive tape, with 3/16 inch white letters on a dark green background.

2.3 WIRE MARKERS

A. Description: Cloth tape, split sleeve, or tubing type wire markers.

B. Legend:
1. Control Circuits: Control wire number as indicated on shop drawings.

2.4 CONDUIT AND RACEWAY MARKERS

A. Description: Nameplate fastened with adhesive, Labels fastened with adhesive or Stencils.

B. Color:
1. Medium Voltage System: Black lettering on white background.
2. 480 Volt System: Black lettering on white background.
3. 208 Volt System: Black lettering on white background.

C. Legend:

1. Medium Voltage System: HIGH VOLTAGE.
2. 480 Volt System: 480 VOLTS.
3. 208 Volt System: 208 VOLTS.

2.5 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. Up to 2 inches Outside Diameter of Raceway: 1/2-inch-high letters.
   2. 2-1/2 to 6 inches Outside Diameter of Raceway: 1 inch high letters.

2.6 UNDERGROUND WARNING TAPE

A. Description: 6-inch-wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

2.7 LOCKOUT DEVICES

A. Lockout Hasps:
   1. Anodized aluminum or Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

2.8 POSTED OPERATING INSTRUCTIONS

A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:
   1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
   2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
   3. Safety precautions.
   4. The procedure in the event of equipment failure.
   5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.
   6. At a minimum, operating instructions shall be provided for fire alarm panels, ATSs, generators, switchgear.

B. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

2.9 MANUFACTURER'S NAMEPLATE

A. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.10 FIELD FABRICATED NAMEPLATES

A. ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each

nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125-inch-thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25-inch-high normal block style.

## 2.11 WARNING SIGNS

A. Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.
   1. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2-inch-high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

## 2.12 ARC FLASH HAZARD IDENTIFICATION

A. Arc Flash Warning Labels: Per ANSI Z535.4, the signal word WARNING appearing in black letters on an orange background, with second line below (Arch Flash and Shock Hazard) in black letters on white background and third line below (Appropriate PPE required) in black letters on white background.
   1. Include the following information on the label:
      a. Equipment name.
      b. Available bolted current.
      c. Flash protection boundary distance.
      d. Incident energy level at 18” expressed in cal/cm2.
      e. Personnel protective equipment (PPE) class.
      f. Voltage shock hazard.
      g. Limited shock approach boundary.
      h. Restricted shock approach boundary.
      i. Prohibited shock approach boundary.
   2. It shall be the Electrical Contractors responsibility to produce the information necessary to complete the above-described warning labels. Provide the services of a qualified engineer if required to calculate these values.

# PART 3 EXECUTION

## 3.1 PREPARATION

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

## 3.2 EXISTING WORK

A. Install identification on existing equipment to remain in accordance with this section.

B. Install identification on unmarked existing equipment

C. Replace lost nameplates labels markers.

D. Re-stencil existing equipment as required.

3.3 INSTALLATION

A. Install identifying devices after completion of painting.

B. Fire alarm, emergency/critical power, life safety labels, including receptacles, shall be color coded and engraved.

C. Provide each panel with a manufacturer prepared arc flash hazard warning label.

D. Provide a typed panel directory for each panel provided or modified for this project. Directory shall identify the circuit number, loads served, and location of loads by room number. Mount on inside of each panel and file with the owner when the work is complete.

E. Nameplate Installation:
1. Install nameplate parallel to equipment lines.
2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
4. Secure nameplate to equipment front using screws or rivets.
5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
6. Install nameplates for the following:
   a. Switchboards.
   b. Panelboards.
   c. Transformers.
   d. Disconnects and starters.
   e. VFDs
   f. ATSs
   g. Lighting contactors
   h. Equipment enclosures
   i. Controls cabinets and enclosures

F. Label Installation:
1. Install label parallel to equipment lines.
2. Install label for identification of individual control device stations.
3. Install labels for permanent adhesion and seal with clear lacquer.
4. Install panel name and circuit number identification labels for the following:
   a. Junction boxes (permanent marker may be used for junction boxes in mechanical spaces or above lay in ceilings.)
   **b. Receptacle cover plates in areas other than dwelling units.**

G. Wire Marker Installation:
1. Install wire marker for each conductor at panelboards, gutters, pull boxes, at electrical equipment such as contactors and disconnects, and each load connection.

2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
3. Install labels at data outlets identifying patch panel and port designation.

H. Raceway Marker Installation:
1. Install raceway marker for each raceway longer than 6 feet and rated 100A or more.
2. Raceway Marker Spacing: provide marker in a visible location in each room where raceway passes through walls or floors.
3. Coordinate with architect before labeling raceways in finished spaces

I. Junction and Pull Box Installation
1. Label all junction boxes with the panel, circuit number, and voltage with permanent marker. For boxes exposed in finished spaces, label the inside of the cover.
2. Box for communications, fire alarm, and access control shall be provided with color coded covers. Coordinate color to be used with owner.

J. Underground Warning Tape Installation:
1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

K. Warning Sign Mounting
1. Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

## 3.4 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

# SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies to be performed by equipment manufacturer's representative. Protective devices shall be field set by contactor based on results of the protective device coordination study.

### 1.2 RELATED DOCUMENTS

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

### 1.3 SUBMITTALS

A. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form. Provide proposed methodology for approval prior to conducting actual study. Proceed with study upon approval of methodology by Engineer.
   1. Study and Equipment Evaluation Reports.
   2. Coordination-Study Report.

B. Short circuit analysis shall be performed concurrent with equipment submittal (prior to ordering equipment with overcurrent protective devices) to verify that all equipment had adequate AIC ratings for the available fault current to which it will be subjected.

### 1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

### 3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Generator thermal-damage curve.
   e. Ratings, types, and settings of utility company's overcurrent protective devices.
   f. Special overcurrent protective device settings or types stipulated by utility company.
   g. Time-current-characteristic curves of devices indicated to be coordinated.
   h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
   i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
   j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

## 3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
   1. Switchgear and switchboard bus.
   2. Medium-voltage controller.
   3. Motor-control center.
   4. Distribution panelboard.
   5. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 IEEE 241 and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10.
      b. ANSI C57.12.22.
      c. ANSI C57.12.40.
      d. IEEE C57.12.00.
      e. IEEE C57.96.
   2. Medium-Voltage Circuit Breakers: IEEE C37.010.
   3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
   4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

## 3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.

B. Comply with IEEE 141 IEEE 241 IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION

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# SECTION 26 05 75 - ARC FLASH HAZARD ANALYSIS STUDY

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes,
   1. Performance of an arc flash calculations using the equations described by either NFPA 70E-2015 or IEEE Standard 1584-2002. These equations will produce the necessary flash protection boundary distances and incident energy to determine the minimum PPE requirement
   2. Labels shall be produced based on the results, submitted for review, and then field installed by the contractor.
   3. Note that a computer based a short circuit analysis followed by a coordination study must be performed as a prerequisite for the arc flash analysis.

### 1.2 RELATED DOCUMENTS

A. Division 260573 Overcurrent Protective Device Coordination Study.

### 1.3 ACTION SUBMITTALS

A. Other Action Submittals: The following submittals shall be made after the approval process of methodology has been completed. Submittals may be in digital form. Provide proposed methodology for approval prior to conducting actual study. Proceed with study upon approval of methodology by Engineer.
   1. Arc Flash Hazard Study.
   2. Personal Protective Equipment (PPE) recommendations based on the Study.

### 1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Manual calculations are not acceptable.

B. Comply with NFPA 70E for approved equations and procedures.

C. Comply with IEEE 1584 for approved equations and procedures.

### 1.5 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 SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS SKM SYSTEMS ANALYSIS, INC. www.skm.com SECTION 12345, Copyright ©2007 SKM Systems Analysis, Inc. 12345-3 DATE
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

## PART 2 - PRODUCTS

### 2.1 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with NFPA 70E and IEEE 1584.

## PART 3 - EXECUTION

### 3.1 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. Incident energy
5. Working distance
6. 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 for the main breaker section and one label for the remainder of the MCC (Note: the arc flash incident energy would be different at the vertical section that housed the main breaker, versus down stream vertical sections).
   3. For each low voltage switchboard, one arc flash label shall be provided similar to Item 2, may require 2 labels minimum.
   4. For each switchgear, one flash label shall be provided similar to Item 2, may require one additional label.
   5. For medium voltage switches one arc flash label shall be provided

F. Install labels in field on equipment.

3.2 TRAINING

A. The contractor of the arc flash study shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized electrical equipment.

B. The contractor of the arc flash study 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

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# SECTION 260923 - 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. Section Includes:
1. Outdoor photoelectric switches, solid state, flexible mounting.
2. Daylight-harvesting switching controls.
3. Daylight-harvesting dimming controls, analog.
4. Daylight-harvesting dimming controls, digital.
5. Indoor occupancy and vacancy sensors.
6. Switchbox-mounted occupancy sensors.
7. Lighting contactors.
8. Emergency shunt relay.
9. Conductors and cables.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: [**On USB media**] [**On manufacturer's website**]. Provide names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.

## 1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

2. Warranty Period: One year(s) from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

A. Description: Solid state, with **DPST** dry contacts rated for **1800 VA inductive**, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.

1. Listed and labeled as defined in NFPA 70, by NRTL, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range**, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off**.
3. Time Delay: Fifteen-second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure **from same source and manufacturer as switch**.
6. Failure Mode: Luminaire stays ON.

## 2.2 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: System operates indoor lighting.

C. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.

1. Lighting control set point is based on two lighting conditions:

    a. When no daylight is present.
    b. When significant daylight is present (target level).
    c. System programming is done with two hand-held, remote-control tools.

D. Ceiling-Mounted Switching Controls:

1. Solid-state, light-level sensor unit, with **integrated** power pack, that detects changes in indoor lighting levels that are perceived by the eye.

E. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Sensor Output:

    a. Contacts rated to operate the associated power pack, complying with UL 773A. Sensor shall be powered by the power pack.

4. Sensor type: **Closed loop**.
5. Power Pack:

    a. Dry contacts rated for **20-A LED** load at 120- and 277-V ac, Class 2 power source, as defined by NFPA 70.

        1) LED status lights to indicate load status.
        2) Plenum rated.

6. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
7. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
8. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
9. Test Mode: User selectable, overriding programmed time delay to allow settings check.
10. Control Load Status: User selectable to confirm that load wiring is correct.
11. Indicator: Two digital displays to indicate the beginning of on-off cycles.

## 2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS, ANALOG

A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:

    a. When no daylight is present (target level).
    b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.

    a. Initial setup tool.
    b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with **integrated** power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: zero- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

D. Power Pack: Dry contacts rated for **20-A LED** load at 120- and 277-V ac, for, and for **1 hp** at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

1. LED status lights to indicate load status.
2. Plenum rated.

## 2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

A. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.

1. Lighting control set point is based on the following two lighting conditions:

    a. When no daylight is present (target level).
    b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.

    a. Initial setup tool.
    b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with **integrated** power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: zero- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

D. Power Pack: Digital controller capable of accepting **three** RJ45 inputs with **two** output(s) rated for **20-A LED** load at 120- and 277-V ac, for **13-A LED** at 120- and 277-V ac, and for 1 **hp**at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.

1. With integral current monitoring.
2. Compatible with digital addressable lighting interface.
3. Plenum rated.

## 2.5 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. **Wall, Ceiling**-mounted, solid-state indoor **occupancy and vacancy** sensors.
2. **Passive infrared and Ultrasonic Dual** technology.
3. **Hardwired or Wireless** connection to switch
4. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Operation:
   a. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
6. Power: **Line voltage**.
7. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
8. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
9. Bypass Switch: Override the "on" function in case of sensor failure.
10. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

B. PIR Type: **Wall or Ceiling** mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..

C. Ultrasonic Type: **Wall or Ceiling** mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

D. Dual-Technology Type: **Wall or Ceiling** mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.), and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s .

## 2.6 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox **using hardwired connection, or using wireless connection**.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800-VA **or LED** load at 120 V, 1200-VA **LED** load at 277 V, and 800-W incandescent.

B. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of **900 sq. ft.**.
2. Sensing Technology: **Dual technology - PIR and ultrasonic**.
3. Switch Type: **SP, manual "on," automatic "off."**
4. Capable of controlling load in three-way application.
5. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
6. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
7. Color: Ivory.
8. Faceplate: Color matched to switch.

## 2.7 LIGHTING CONTACTORS

A. Description: Electrically operated and **electrically** held, combination-type lighting contactors with **nonfused disconnect**, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.

4. Provide with control and pilot devices as [**indicated on Drawings**] [**scheduled**], matching the NEMA type specified for the enclosure.

## 2.8 EMERGENCY SHUNT RELAY

A. Description: NC, electrically held relay, arranged for wiring in parallel with manual **or automatic** switching contacts; complying with UL 924.

## 2.9 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than **No. 18** AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than **No. 18** AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

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

## 3.2 INSTALLATION OF SENSORS

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 INSTALLATION OF CONTACTORS

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 INSTALLATION OF WIRING

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's written instructions.

D. Size conductors in accordance with lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems.

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections **with the assistance of a factory-authorized service representative**:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

## 3.7 ADJUSTING

A. Occupancy Adjustments: When requested within **12** months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

## 3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for **two** years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within **two** years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

## 3.9 CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

# SECTION 26 24 13 - SWITCHBOARDS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes main and distribution switchboards.

### 1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI C12.1 - Code for Electricity Metering.
   2. ANSI C39.1 - Requirements, Electrical Analog Indicating Instruments.

B. Institute of Electrical and Electronics Engineers:
   1. IEEE C57.13 - Standard Requirements for Instrument Transformers.
   2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

C. National Electrical Manufacturers Association:
   1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
   2. NEMA FU 1 - Low Voltage Cartridge Fuses.
   3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   4. NEMA PB 2 - Deadfront Distribution Switchboards.
   5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.

D. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

### 1.3 SUBMITTALS

A. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; and switchboard instrument details.

B. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

C. Submit bill of materials.

D. Submit schematics and wiring diagrams for metering and controls.

E. Test Reports: Indicate results of field tests.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.

B. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
   1. Manufacturer shall maintain or certify an independently operated service center capable of providing training, support, parts, and maintenance services.

B. Supplier: Authorized distributor

C. Installer: A state licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications, required by core, or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.6 QUALITY ASSURANCE

A. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.

B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

1.7 WARRANTY

A. Provide manufacturer's standard form clearly stating that manufacturer agrees to repair or replace equipment, materials, and associated auxiliary components that fail or deteriorate within the specified warranty period.

B. Warranty Period: one (1) year from the date of substantial completion

1.8 DELIVERY STORAGE AND HANDLING

A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.

B. Maintain factory wrapping or provide additional canvas or plastic cover for all large electrical equipment. Follow all manufacturer recommendations for humidity and max/min temperatures for storing electrical equipment.

C. Deliver in 48-inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.

D. Accept switchboards on site. Inspect for damage.

E. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

F. Environmental Requirements
   1. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.9 COORDINATION

A. Verify field measurements prior to fabrication.

B. Sequence Work to avoid interferences with building finishes and installation of other products.

1.10 RECOMMENDED PERIODICAL OWNER MAINTENANCE PROCEDURES

A. Perform thermal imaging scan to identify hot spots once per year.

B. Re-torque all lugs to manufacturer recommendations once per year.

C. Exercise circuit breakers per manufacturer's recommendations.

D. For outdoor equipment, de-energize and open equipment to clean out debris, animal nests, etc.

1.11 MAINTENANCE MATERIALS

A. Furnish two of each key.

PART 2 PRODUCTS

2.1 DISTRIBUTION SWITCHBOARDS

A. Manufacturers:
   1. ABB
   2. Siemens
   3. Square D
   4. Eaton
   5. Substitutions: With engineer approval.

B. Product Description: NEMA PB 2, free standing, dead front, enclosed switchboard with electrical ratings and configurations as indicated on Drawings. All vertical sections shall be bolted together to form one assembly.

C. Device Mounting:
   1. Main Section: Individually mounted.
   2. Distribution Section: Group mounted

D. Bus:
   1. Material: Silver plated copper, standard size.
   2. Connections: Bolted, accessible from front for maintenance.

3. AIC Rating is denoted on the one-line diagram.
4. Fully rated neutral

E. Bus Arrangement: Phase A-B-C, left to right, top to bottom, and front to rear, as viewed from the front. Provided main horizontal bus with continuous current rating as shown on Drawings. Main bus shall be full capacity through each section and have provisions for future extension. Main bus and sub-main busses shall be sized to meet UL and NEMA standards for temperature rise.

F. Ground Bus: extend length of switchboard.

G. Line and Load Terminations: Accessible from front only of switchboard, suitable for conductor materials and sizes as indicated on Drawings.

H. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, insulated and braced for short circuit currents. Furnish continuous current rating as indicated on Drawings.

I. Enclosure: Type 1 - General Purpose. unless noted otherwise on plans

J. Align sections at front and rear.

K. Switchboard Height: 90 inches max, excluding floor sills, lifting members and pull boxes.

L. Finish: Manufacturer's standard light gray enamel over a rust inhibiting phosphatized coating on external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

M. Mimic Bus: Show bussing, connections and devices in single line form on front panels of switchboard using black plastic strips, fastened flat against panel face with screws or rivets.

## 2.2 CIRCUIT BREAKER

A. Manufacturers:
1. Provide circuit breakers from the manufacturer of the switchboard enclosure.
2. Substitutions: Not Allowed.

B. Product Description: NEMA AB 1, molded-case circuit breaker.
1. Insulated case circuit breakers to be used as applicable

C. Circuit breakers shall be manufacturer’s standard bolt on type circuit breakers with inverse time delay thermal and instantaneous magnetic trip. Refer to the one line diagram for required trip functions.
1. Where LSI and/or G are noted adjacent to a circuit breaker on the one line diagram, Long, Short, Instantaneous and/or Ground Fault Trip and Delay functions shall be provided for the indicated circuit breaker.
2. Whether noted on one line or not, provide adjustable instantaneous trip for all breakers rated 600A or more.
3. All circuit breakers rated 1200A or more shall be provided with maintenance mode option.

4. Whether noted on one line or not, for distribution breakers rated 400A or more, provide solid state trip units with the following adjustable trip settings
   a. Long Time Trip
   b. Long Time Delay
   c. Short Time Trip
   d. Short Time Delay
   e. Instantaneous Trip
   f. Ground Fault Trip
   g. Ground Fault Delay
5. Where the main distribution panel's main circuit breaker is provided with ground fault protection, all circuit breakers in the main distribution panel shall also be provided with ground fault protection.

D. Instantaneous pick up shall range from 5 to 10 times trip rating minimum.

E. Field-Changeable Ampere Rating Circuit Breaker: Circuit breakers with frame sizes 2000A amperes and larger have changeable trip units.

2.3 GROUND FAULT DEVICES

A. Provide ground fault protection on each disconnect device, rated 1000 amps or above and where noted on one line diagram.

B. Use zero sequence fault arrangement.

C. Provide U.L. listed ground fault relay system with coordinated ground sensor with integral test winding and solid-state relay to operate with protective device shunt trip circuit.

D. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 3 seconds. Furnish monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

2.4 SOURCE QUALITY CONTROL

A. Furnish shop inspection and testing in accordance with NEMA PB 2.

B. Provide proof of factory inspections and tests at manufacturer's test facility.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify surface is suitable for switchboard installation.

3.2 EXISTING WORK

A. Disconnect and remove abandoned switchboards.

B. Maintain access to existing switchboards and other installations remaining active.

C. Clean and repair existing switchboards to remain or to be reinstalled.

3.3 INSTALLATION

A. Install switchboards as indicated in accordance with manufacturer's written instructions and applicable requirements of the NEC, NEMA, ANSI and applicable requirement of the National Electrical Contractors Association's "Standard of Installation." Install per NEMA PB 2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

C. Install engraved plastic nameplates in accordance with Section 26 05 53.

D. Install breaker circuit directory.

E. Ground and bond switchboards in accordance with Section 26 05 26.

F. Switchboard shall be bolted directly to floor without the use of floor sills.

3.4 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.1.

3.5 ADJUSTING

A. Adjust operating mechanisms for free mechanical movement.

B. Tighten electrical bus connections with torque wrench to manufacturer's recommendations.

C. Adjust circuit breaker trip and time delay settings to values per protective device settings table

3.6 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

B. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

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# SECTION 26 24 16 - PANELBOARDS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes
1. Distribution panels
2. Branch circuit panelboards,
3. Electronic grade branch circuit panelboards.

### 1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers:
1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

B. National Electrical Manufacturers Association:
1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
2. NEMA FU 1 - Low Voltage Cartridge Fuses.
3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
6. NEMA PB 1 - Panelboards.
7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

C. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

D. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.S

E. Underwriters Laboratories Inc.:
1. UL 67 - Safety for Panelboards.
2. UL 1283 - Electromagnetic Interference Filters.
3. UL 1449 – 4th Edition – Standard for Surge Protective Devices

### 1.3 SUBMITTALS

A. Shop Drawings: Manufacturer or contractor prepared drawings showing all relevant dimensions, weights, mounting requirements, and conduit entry points.
1. Include dimensioned plan views and elevations.

B. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
   1. Include amperage ratings, voltage, over-current protective device ratings, AIC ratings.
   2. Where multiple sizes are listed, indicate sizes to be used.
   3. Where multiple products are shown on the same page, indicate which products to be used.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of electrical equipment and record actual circuiting arrangements.

B. Operation and Maintenance Data:
   1. Provide product data as defined under submittals.
   2. Provide manufacturer's installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
   3. Submit spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
   1. Manufacturer shall maintain or certify an independently operated service center capable of providing training, support, parts, and maintenance services.

B. Supplier: Authorized distributor

C. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.6 QUALITY ASSURANCE

A. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.

B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

1.7 WARRANTY

A. Provide manufacturer's standard form clearly stating that manufacturer agrees to repair or replace equipment, materials, and associated auxiliary components that fail or deteriorate within the specified warranty period.

B. Warranty Period: one (1) year from the date of substantial completion

1.8 DELIVERY STORAGE AND HANDLING

A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.

B. Maintain factory wrapping or provide additional canvas or plastic cover for all large electrical equipment. Follow all manufacturer recommendations for humidity and max/min temperatures for storing electrical equipment.

1.9 MAINTENANCE MATERIALS

A. Furnish four of each panelboard key. Panelboards keyed alike.

PART 2 PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

A. Manufacturers:
   1. Eaton
   2. ABB
   3. Siemens
   4. Square D
   5. Substitutions: With engineer approval.

B. Product Description: NEMA PB 1, circuit breaker type panelboard.

C. Panelboard Bus:
   1. Copper current carrying components, ratings as indicated on Drawings.
   2. Furnish copper ground bus in each panelboard.
   3. Furnish fully rated copper neutral bus in each panelboard.

D. Minimum integrated short circuit rating: as shown on plans

E. Molded Case Circuit Breakers:
   1. NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
   2. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
   3. Where LSI and/or G are noted adjacent to a circuit breaker on the one line diagram, Long, Short, Instantaneous and/or Ground Fault Trip and Delay functions shall be provided for the indicated circuit breaker.
   4. Whether noted on one line or not, provide adjustable instantaneous trip for all breakers rated 600A or more.
   5. All circuit breakers rated 1200A or more shall be provided with maintenance mode option.
   6. Whether noted on one line or not, for distribution breakers rated 600A or more, provide solid state trip units with the following adjustable trip settings
      a. Long Time Trip
      b. Long Time Delay

c. Short Time Trip
d. Short Time Delay
e. Instantaneous Trip
f. Ground Fault Trip
g. Ground Fault Delay

7. Where the main distribution panel's main circuit breaker is provided with ground fault protection, all circuit breakers in the main distribution panel shall also be provided with ground fault protection.

F. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated on Drawings.

G. Enclosure: NEMA PB 1, Type 1 unless noted otherwise
1. Dimensions shall not be significantly greater than similar panels from the manufacturers listed above.
2. Cover: Flush cabinet front with continuous hinge.
3. Door: Hinged, metal directory frame, and flush latch and lock, all keyed alike.
4. Finish in manufacturer's standard gray enamel except as noted below.
5. For panels on building exteriors in visible locations, paint to match surface to which they are attached.

## 2.2 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. Eaton
2. ABB
3. Siemens
4. Square D
5. Substitutions: With engineer approval.

B. Product Description: NEMA PB 1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus:
1. Silver tinned plated copper current carrying components, ratings as indicated on Drawings.
2. Furnish copper ground bus in each panelboard.
3. Furnish fully rated copper neutral bus in each panelboard.

D. Minimum Integrated Short Circuit Rating: 10KAIC unless higher value indicated on Drawings.

E. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as:
1. Type SWD for lighting circuits.
2. Type HACR for air conditioning equipment circuits.
3. Class A ground fault interrupter circuit breakers as indicated on Drawings.
4. UL 1699 compliant arc flash circuit interrupter for all circuits serving receptacles in every room of dwelling units.
5. Do not use tandem circuit breakers.

F. Enclosure: NEMA PB 1, Type 1 unless noted otherwise
   1. 6 inches deep, 20 inches wide.
   2. Cover: Flush cabinet front with continuous hinge.
   3. Door: continuous hinge, metal directory frame, and flush lock keyed alike.
   4. Finish in manufacturer's standard gray enamel except as noted below.
   5. For panels on building exteriors in visible locations, paint to match surface to which they are attached.

## PART 3 EXECUTION

### 3.1 EXISTING WORK

A. Disconnect abandoned panelboards and remove. Install blank cover for abandoned panelboards and load centers that are noted to remain.

B. Maintain access to existing panelboard remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing panelboards to remain or to be reinstalled.

### 3.2 INSTALLATION

A. Install panelboards:
   1. In accordance with NEMA PB 1.1.
   2. Plumb with adjacent walls and supports.
   3. Flush with wall finishes if recessed in wall.
   4. By securing all four corners to the adjacent structure using appropriate supports.
   5. On concrete pads if floor mounted.

B. Provide each panel with:
   1. Filler plates for unused spaces in panelboards.
   2. Typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.
   3. Engraved plastic nameplates identifying panel name, source, amperage, and voltage.

C. Mounting Requirements
   1. Elec/Mech Rms, Warehouses, Industrial Locations, Closets: Surface mount using u-channel supports behind panel to stand panel off wall. In constrained spaces, panels may be secured directly to the wall where required to provide access to equipment, meet egress requirements, or NEC working space requirements.
   2. Finished Corridors, Lobbies, Office Areas: Recess mount panels in wall. Coordinate with general contractor to ensure wall thickness is adequate to flush mount panels. (6” studs, typical).
   3. Where panels are surface mounted in corridors or other egress pathways, provide sheet metal skirt from bottom edge of panel to finished floor for ADA compliance.
   4. Exterior Building Walls: Surface mount using galvanized u-channel supports behind panel to stand panel off wall.
   5. Exterior Free Standing: Mount to galvanized u-channel rack with minimum of two (2) horizontal supports behind panel and one (1) horizontal support below panel to secure

conduits. Vertical supports shall be imbedded in concrete foundation or bolted to concrete pad. If bolted to pad, provide 45-degree angle braces attached to vertical support one foot or more above pad.

6. Mounting Height:
   a. Interior Spaces: 6 feet to top of panelboard.
   b. Install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
   c. Exterior: To help shield from view, mount panels as low as practical. Bottom of panel shall be at least 18" AFG unless floor mounted or mounted over concrete, asphalt, etc.

D. Install spare conduits out of each recessed panelboard to accessible location above ceiling. Minimum spare conduits: 5 empty 1 inch. Identify each as SPARE.

E. Grounding
   1. Ground and bond panelboard enclosure according to grounding specifications and code.
   2. Connect equipment ground bars of panels in accordance with NFPA 70.

F. Provide main distribution panel with meter as described above. Provide other panels with meters were noted on plans.

## 3.3 FIELD QUALITY CONTROL

A. Tighten all accessible electrical connections to the manufacturer's torque specifications.

B. Remove all blocks, packing and shipping materials, and foreign materials.

C. Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain they operate freely.

D. Check integrity of all electrical and mechanical interlocks and padlocking mechanisms.

E. Conduct an insulation resistance test phase to ground and phase to phase with the OCPDs in both the open and closed position. Resistance in open position shall be 1 megohm min. Remediate and retest if resistance is less. Verify that any metering or surge protection equipment that could be damaged by this testing has been disconnected and or removed as needed for testing.

F. Test all ground fault protection systems in accordance with the manufacturer's instructions.

## 3.4 ADJUSTING

A. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

## 3.5 CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

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# SECTION 26 24 20 - SURGE PROTECTION DEVICES

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes surge protection devices (SPDs) for protection of electrical distribution systems, also known as transient voltage surge suppressors.

### 1.2 REFERENCES

A. Underwriters Laboratories; ANSI/UL 1449 Fourth Edition

B. Underwriters Laboratories; UL 1283 (complimentary listing for Type 2 locations)

C. Canadian Underwriters Laboratories (cUL)

D. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.34, C62.41, C62.45)

E. Institute of Electrical and Electronic Engineers 1100 Emerald Book

F. Federal Information Processing Standards Publication 94 (FIPS PUB 94)

G. National Fire Protection Association (NFPA 20, 70, 75 and 780)

H. International Standards Organization (ISO) Company certified ISO 9001 for manufacturing, design and service

I. Conformité Européenne (CE)

J. Federal Communications Commission (FCC)Underwriters Laboratories Inc.:

### 1.3 SUBMITTALS

A. Shop Drawings: Manufacturer or contractor prepared drawings showing all relevant dimensions, weights, mounting requirements, and conduit entry points.
   1. Include dimensioned plan views and elevations.

B. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
   1. Include amperage ratings, voltage, over-current protective device ratings, AIC ratings.
   2. Where multiple sizes are listed, indicate sizes to be used.
   3. Where multiple products are shown on the same page, indicate which products to be used.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of electrical equipment and record actual circuiting arrangements.

B. Operation and Maintenance Data:
   1. Provide product data as defined under submittals.
   2. Provide manufacturer's installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
   3. Submit spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
   1. Manufacturer shall maintain or certify an independently operated service center capable of providing training, support, parts, and maintenance services.

B. Supplier: Authorized distributor

C. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.6 QUALITY ASSURANCE

A. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.

B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

1.7 WARRANTY

A. Provide manufacturer's standard form clearly stating that manufacturer agrees to repair or replace equipment, materials, and associated auxiliary components that fail or deteriorate within the specified warranty period.

B. Warranty Period: one (1) year from the date of substantial completion

1.8 DELIVERY STORAGE AND HANDLING

A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.

B. Maintain factory wrapping or provide additional canvas or plastic cover for all large electrical equipment. Follow all manufacturer recommendations for humidity and max/min temperatures for storing electrical equipment.

1.9 MAINTENANCE MATERIALS

A. Furnish four of each panelboard key. Panelboards keyed alike.

PART 2 PRODUCTS

2.1 ENVIRONMENTAL

A. General Requirements:
   1. No audible noise shall be generated.
   2. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.
   3. Operating Conditions:
      a. Operating Temperature: -40 to +60°C (-40 to +140°F)
      b. Relative Humidity: 0% to 95% (non-condensing)
      c. Audible Noise: less than 45dB at 5 feet (1.5m)
      d. Operating Altitude: 0 to 18,000 feet above sea level
   4. Enclosure: The unit shall have a heavy-duty steel NEMA 4 water-tight, dust-tight, drip-tight enclosure unless specified otherwise.

2.2 TYPE 1 SPD - GENERAL REQUIREMENTS

A. SPD shall be rated for a **system** voltage, 60 Hertz, 3-phase, 4-wire system and shall be connected in parallel with the main.

B. Quality: The manufacturer shall be ISO 9001:2000 certified, demonstrating world-class quality systems for the design and manufacture of the surge protective devices.

C. The unit shall be tested and certified by Underwriters Laboratories to the ANSI/UL 1449 Fourth Edition Standard for Surge Protective Devices and the resulting voltage protection ratings (VPRs) shall be permanently affixed to the SPD.

D. The system shall be constructed using multiple surge current diversion modules utilizing metal oxide varistors (MOV) computer matched to a variance of ±1 volt and tested for manufacturing defects. The modules shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

**E.** Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC. **Devices that accomplish this rating by suggesting or providing additional fusing to the SPD system will not be accepted.**

**F.** All surge current diversion module connections shall be by way of low-impedance copper plates. Surge current diversion modules shall use bolted connections to the plates for reliable, low-impedance connections. The system shall be designed for easy servicing by a qualified field electrician, providing simple change out of any or all TVSS modules. Designs that require factory service are not acceptable. Any unit using "plug-in" type modules are not acceptable. All connections, conductors and terminals must be appropriately sized for specified surge current capacity

G. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of each phase of the unit.

H. Unit shall have 2 sets of Form C summary alarm output contacts rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

2.3 TYPE 1 SPD - MANUFACTURERS AND SPECIFIC PRODUCT REQUIREMENTS

A. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows, **no substitutions**:
1. ASCO: 560 SPD (500 Series)
2. Current Technology: SEL Series
3. Selected gear manufacturer

B. Unit shall be ANSI/UL 1449 Fourth Edition, Type 1 listed with a nominal discharge current rating (In) of 20kA

C. Unit shall provide maximum ANSI/UL 1449 Fourth Edition, VPRs for 208Y/120 Volt systems as follows:
1. L-N = 700V
2. L-G = 700V
3. N-G = 700V
4. L-L = 1000V

D. Unit shall provide maximum ANSI/UL 1449 Fourth Edition VPRs for 480Y/277 Volt systems as follows:
1. L-N = 1000V
2. L-G = 1200V
3. N-G = 1000V
4. L-L = 1800V

E. Separate and replaceable suppression modules will protect each mode (L-N, L-G, and N-G).

F. The service entrance SPD will be capable of surviving 15,000 ANSI/IEEE, Category C3 (10kA) impulses per mode (30,000 per phase) without failure or degradation of original performance characteristics of more than 10%

G. Unit shall have a maximum surge current rating of 125,000 amperes L-N, 125,000 amperes L-G, and 125,000 amperes N-G, based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.

H. Unit shall include a built-in, push-to-test feature that tests the integrity of all modules, MOVs and fuses in the system. **Manufacturers that require an external test device to perform this feature will include the test set in this quotation**.

I. Unit shall have an audible alarm with an alarm on/off switch to silence the alarm and a push-to-test switch to test the alarm function.

J. Unit shall be provided with an integral, **non-fused** disconnect switch which causes no interruption to the protected load for testing and maintenance. Disconnect system shall not require removal or replacement for warranty or other repairs.

K. Warranty: Manufacturer shall provide a product warranty for a period of not less than 10 years from date of installation. Warranty shall cover unlimited replacement of system protection modules during warranty period. The first 5 years of this warranty will include any field labor required to perform repair or replacement work.

## 2.4 ENVIRONMENTAL

A. General Requirements:
1. No audible noise shall be generated.
2. No appreciable magnetic fields shall be generated. System shall be capable of use directly in computer rooms in any location without danger to disc units, disk packs, or tapes.
3. Operating Conditions:
   a. Operating Temperature: -40 to +60°C (-40 to +140°F)
   b. Relative Humidity: 0% to 95% (non-condensing)
   c. Audible Noise: less than 45dB at 5 feet (1.5m)
   d. Operating Altitude: 0 to 18,000 feet above sea level

B. Enclosure: The unit shall have a heavy duty NEMA 4X, water-tight, dust-tight, drip-tight enclosure.

## 2.5 TYPE 2 SPD - GENERAL REQUIREMENTS

A. Branch Panel Equipment: Rated for **system** voltage, 60 Hertz, 3-phase, 4-wire.

B. Quality: The manufacturer shall be ISO 9001:2000 certified, demonstrating world-class quality systems for the design and manufacture of the surge protective devices.

C. The unit shall be tested and certified by Underwriters Laboratories to the ANSI/UL 1449 Fourth Edition Standard for Surge Protective Devices and the resulting voltage protection ratings (VPRs) shall be permanently affixed to the SPD.

D. The system shall be constructed using multiple surge current diversion arrays utilizing metal oxide varistors (MOV) computer matched to a variance of ±1 volt and tested for manufacturing defects. The arrays shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

**E.** Each surge suppression element (MOV) shall be individually fused so that a failure of one element and/or fuse shall not affect other surge suppression elements. SPD shall have a short-circuit rating of 200kAIC. **Devices that accomplish this rating by suggesting or providing additional fusing to the SPD system will not be accepted.**

**F.** The unit shall be designed to be installed using the flexible conduit provided by the TVSS manufacturer. All parallel connections to the TVSS shall be kept as short as possible. The connection to the TVSS shall be made using #10 AWG maximum (ring terminal shall be provided).

G. Unit shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status and operational integrity of the unit.

H. Unit shall have a Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

I. Unit shall have an audible alarm with an alarm enable/disable feature to silence the alarm.

## 2.6 TYPE 2 SPD - MANUFACTURERS AND PRODUCT REQUIREMENTS

A. Acceptable Manufacturers: Subject to compliance with requirements of the Contract Documents, acceptable manufacturers are as follows, **no substitutions**:
   1. ASCO: 510 SPD (500 Series)
   2. Current Technology: TG Series
   3. Selected gear manufacturer

B. Unit shall be ANSI/UL 1449 Fourth Edition, Type 1 listed with a nominal discharge current rating of 20kA.

C. Unit shall provide maximum ANSI/UL 1449 Fourth Edition, VPRs for 208Y/120 Volt systems as follows:
   1. L-N = 600V
   2. L-G = 700V
   3. N-G = 600V
   4. L-L = 900V

D. Unit shall provide maximum ANSI/UL 1449 Fourth Edition, VPRs for 480Y/277 Volt systems as follows:
   1. L-N = 1000V
   2. L-G = 1000V
   3. N-G = 900V
   4. L-L = 1800V

E. The branch panel SPD will be capable of surviving 8,000 ANSI/IEEE, Category C3 (10kA) impulses per mode (16,000 per phase) without failure or degradation of original performance characteristics of more than 10%

F. Unit shall have a maximum surge current rating of 80,000 amperes L-N, 80,000 amperes L-G, and 80,000 amperes N-G, based on ANSI/IEEE C62.41 standard 8 by 20 microsecond current waveform.

G. Form C summary alarm output contact rated for at least 1 amp at 120VAC for remote annunciation of SPD status.

H. The SPD will be connected to the panelboard bus bar or through a dedicated 30A breaker provided by the equipment manufacturer.

I. Warranty: Manufacturer shall provide a product warranty for a period of not less than 10 years from date of installation.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. Contractor shall install suppression system immediately next to or on top of service equipment where so approved by the Engineer:

B. Conductors between suppressor and point of attachment to service equipment shall be sized in accordance with manufacturer's Shop Drawings and conductor lengths shall be as short as possible, preferably not exceeding 24":

C. Grounding: Suppressor ground shall be bonded to the equipment grounding conductor and service entrance ground

### 3.2 FIELD QUALITY CONTROL

A. Tighten all accessible electrical connections to the manufacturer's torque specifications.

B. Remove all blocks, packing and shipping materials, and foreign materials.

### 3.3 ADJUSTING AND CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

# SECTION 26 27 26 - WIRING DEVICES

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes
1. Wall switches
2. Wall dimmers
3. Receptacles
4. Floor-boxes
5. Device plates and decorative box covers.
6. Occupancy sensors

### 1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 1 - General Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

### 1.3 SUBMITTALS

A. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
1. Include amperage and voltage ratings.
2. Include color to be used for each wiring device. Architect to select and approve device colors
3. Device and cover plate shall not be ordered until color selections are approved in writing by architect.
4. Where multiple sizes are listed, indicate sizes to be used.
5. Where multiple products are shown on the same page, indicate which products to be used.

### 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of each floor box and poke-through fitting.

B. Operation and Maintenance Data:
1. Provide product data as defined under submittals.
2. Provide manufacturer’s installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
3. Submit spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

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

B. Supplier: Authorized distributor

C. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.6 QUALITY ASSURANCE

A. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.

B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

1.7 WARRANTY

A. Warranty Period: one (1) year from the date of substantial completion

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Wiring device type and color shall be location specific.
   1. In general, use “architectural style” devices in public areas and heavy-duty device in back of house.
   2. Device color shall be selected by architect.
   3. Use Ivory devices if and only if no selection is made by architect.

2.2 WALL SWITCHES

A. Manufacturers:
   1. Cooper Wiring Devices
   2. Harvey Hubbell, Inc.
   3. Leviton Manufacturing Company.
   4. Substitutions: With engineer approval.

B. Product Description:
   1. NEMA WD 1, General-Duty, commercial grade, AC only general-use snap switch, unless noted otherwise.
   2. Provide heavy duty industrial grade switches in janitor's closet, mechanical rooms, manufacturing areas, and labs.
   3. One-piece brass integral ground terminal

C. Ratings:
   1. Voltage: 120-277volts, AC.
   2. Current: 20 amperes.
   3. 1HP-120V, 2HP 240-277V

D. Body and Handle:
   1. Nylon.
   2. Provide toggle switches in finished areas.
   3. Provide toggle switches in un-finished areas such as janitor's closet, mechanical rooms, manufacturing areas, and labs.

2.3 WALL DIMMERS

A. Manufacturers:
   1. Cooper Wiring Devices
   2. Harvey Hubbell, Inc.
   3. Leviton Manufacturing Company.
   4. Substitutions: With engineer approval.

B. Product Description:
   1. NEMA WD 1
   2. Semiconductor dimmer for incandescent lamps only.

C. Body and Handle:
   1. Slide dimmer
   2. Nylon
   3. Push button on off control

D. Voltage: 120-277 volts.

E. Power Rating: Match load shown on drawings, 1000W minimum

F. Accessory Wall Switch: Match dimmer appearance.

2.4 RECEPTACLES

A. Manufacturers:
   1. Cooper Wiring Devices
   2. Harvey Hubbell, Inc.
   3. Leviton Manufacturing Company.
   4. Substitutions: With engineer approval.

B. Product Description:

1. NEMA WD 1, General-duty, commercial grade receptacle, unless noted otherwise.
2. Provide heavy duty industrial grade receptacles in janitor's closets, mechanical rooms, manufacturing areas, and labs.
3. One-piece brass integral ground straps
4. Ground retention clips
5. Back wired ground terminals
6. Face and body: nylon

C. Controlled Receptacles
1. Face and body of receptacles that are switched by occupancy sensing device or other means shall have permanent marking indicating which outlet is switched.
2. All Marking shall be manufacturer applied and permanent.
3. Marking shall include universal power symbol adjacent to each switched outlet.
4. Receptacle shall also say "CONTROLLED"
5. Where only one of two receptacles in a duplex are switched, switched outlet shall have permanent manufacturer marking such as color coding or square box around the switched receptacle.

D. Minimum rating: 20A, 125V

E. Configuration: NEMA WD 6, type as indicated on Drawings.

F. Convenience Receptacle:
1. Type 5-20, unless noted otherwise
2. 2 pole, 3 wire grounding

G. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

H. USB Charging Receptacles:
1. Each USB/Duplex receptacle combination shall have:
   a. Two USB 2.0 ports
   b. 2.0 Amps, 5 Volts DC, Type A.
   c. USB port shall be rated for at minimum 10,000 insertions and removals

## 2.5 WALL PLATES

A. Manufacturers:
1. Provide product by the manufacturer of the wiring device being covered by the wall plate

B. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch-thick, satin-finished, Type 302 stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover; in-use type.

## 2.6 FLOOR BOXES

A. Manufacturers:
1. Hubbell
2. Wiremold
3. Substitutions: With engineer approval.

B. Product Description
1. NEMA OS 1
2. Four gang deep boxes,
   a. Provide two duplex receptacles per receptacle specification above.
   b. Provide two data mounting plates.
   c. Power and data shall be on opposite sides of the box, with angled mounting plates and adequate space inside box to completely enclose 4 power plugs and data cables with the cover closed.
3. Flush mounted flanged cover
   a. Shall meet UL requirements for scrub water exclusion
   b. Provide with provisions for carpet or tile insert into cover
   c. Two cable doors within cover, one each for power and data
4. Fully adjustable, field configurable
5. Tamper-Resistant:
   a. All dwellings, guest rooms and guest suites in hotels/motels, and childcare facilities shall be provided with tamper resistant
   b. All other locations as required by code and or noted on the plans
   c. Provide at all other locations as noted.
6. GFCI Rated: Unless noted otherwise or provided at circuit breaker, all receptacles at the following locations shall have integral ground fault circuit interrupt units:
   a. All exterior locations, including roof mounted or under canopies.
   b. Within 6ft of sinks, hose bibs, or other sources of water.
   c. Janitor's closets
   d. All other locations as required by code and or noted on the plans

C. Material:
1. Use cast or stamped steel.
2. Cover shall be cast aluminum.
3. Where floor box is being installed in a slab on grade, provide box rated for on grade application.

D. Shape: Rectangular

E. Configuration:
1. Two duplexes and two communications outlets in open areas
2. Furniture feed type where installed under system furniture or conference tables that are provided with integral receptacles. Contractor shall verify before ordering floor box.

## 2.7 POKE-THROUGH FITTINGS

A. Manufacturers:
1. Hubbell
2. Wiremold
3. Substitutions: With engineer approval.

B. Product Description:
   1. Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination
   2. Provide one duplex receptacle per receptacle specification above, circuited as noted.
   3. Provide one data mounting plate.
   4. Power and data shall have separate raceways through poke-through to floor below.

C. Fire Rating: 3 hours.

D. Service Fitting Type: Flush.

E. Housing: Satin aluminum. Coordinate with architect before ordering

F. Device Plate: Stainless steel

G. Configuration:
   1. One duplex and one communications outlet in open areas
   2. Furniture feed type where installed under system furniture or conference tables that are provided with integral receptacles. Contractor shall verify before ordering poke through.

## 2.8 OCCUPANCY SENSORS - LINE VOLTAGE

A. Specification for daylight sensors that are part of a low-voltage controlled system are found in Section 26 09 23 –Lighting Control Devices.

B. Manufacturers:
   1. Cooper
   2. Douglas Lighting Controls
   3. Hubbell
   4. Leviton
   5. Lutron
   6. Watt Stopper
   7. Substitutions: With engineer approval.

C. Product Description:
   1. Devices shall include both infrared and ultrasonic sensing (elsewhere noted dual technology or mult-technology)
   2. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 30 minutes.
   3. Operation shall be silent.
   4. Integral daylight sensing with automatic shutoff at field adjustable light level.
   5. 1000VA at 120V, 2700VA at 277V rated
   6. 2000 sq. ft. coverage area.
      a. 1000 sq. ft. coverage may be used for room 800 sq ft or less, except restrooms and cubicle areas.
      b. 500 sq. ft. or less coverage devices shall not be used.
      c. Ceiling mounted sensors
      d. 360-degree sensing, unless noted 180-degree.
      e. Ultrasonic sensors on both side of device, unless noted 180-degree.
      f. Device shall be capable of being wired in parallel with additional occupancy sensors for large spaces.

7. Wall mounted sensors
    a. Integral on/off pushbutton
    b. 180-degree sensing

D. Programming
1. Set off delay to 15 minutes minimum.
2. Set off delay to 30 minutes in open office areas and restrooms.
3. Start in the morning and periodically check light levels throughout the day. Set daylight sensing automatic shutoff at the time when and if 40FCs are first measured at 36 inches above floor in the area controlled by the sensor.
4. Set daylight sensing as follows: switch lighting off, temporarily set off-delay to 0, verify adequate foot-candle levels, switch lighting on, and adjust dial until lights switch off
5. Any lighting within the space that is not controlled by the sensor should remain on throughout the programming process.
6. More detail procedures for daylight sensor programming are required when daylight controls are used for selective switching of specific lights within a space that are located near sources of daylight. The procedures described here apply to whole room occupancy sensors only.

E. Dual Relay devices:
1. Where occupancy sensors are indicated on the architectural, mechanical, or electrical plans to control additional equipment (exhaust fans, outside air dampers, etc.), provide sensor with a second dedicated relay with appropriate voltage and power rating for the equipment to be served.
2. Electrical contractor shall coordinate with GC, mechanical contractor, and controls contractors to determine all locations where dual relays are required and insure the appropriate model device is ordered.

F. Corridor and Hallway Sensors:
1. Capable of detecting motion 14 feet wide and 80 feet long with one sensor mounted 10 feet above floor.
2. Capable of detecting motion in warehouse aisle 10 feet wide and 60 feet long or 100 feet long when mounted 22 feet above floor.
3. Device shall be capable of being wired in parallel with additional occupancy sensors

2.9 PHOTOCELLS (DAYLIGHT SENSORS) – LINE VOLTAGE

A. Specification for daylight sensors that are part of a low-voltage controlled system are found in Section 26 09 23 –Lighting Control Devices.

B. Manufacturers:
1. Cooper
2. Douglas Lighting Controls
3. Hubbell
4. Leviton
5. Lutron
6. Watt Stopper
7. Substitutions: With engineer approval.

C. Product Description:
1. Photoelectric light level sensor
2. Separate sensitivity and time delay adjustments. User adjustable time-delay: 30 seconds to 30 minutes.
3. Operation shall be silent.
4. 1000VA at 120V, 2700VA at 277V rated
5. 2000 sq. ft. coverage area.
   a. 1000 sq. ft. coverage may be used for room 800 sq. ft. or less, except restrooms and cubicle areas.
   b. 500 sq. ft. or less coverage devices shall not be used.
6. Device shall be capable of being wired in parallel with additional sensors for large spaces.

D. Sensor Devices: Each sensor employs photo diode technology to allow linear response to daylight within illuminance range.
1. Exterior Lighting: Hooded sensor, horizontally mounted, employing flat lens, and working range 1-100 foot-candles in 10 percent increments. Entire sensor encased in optically clear epoxy resin.
2. Indoor Lighting: Sensor with Fresnel lens providing for 60-degree cone shaped response area to monitor indoor office lighting levels.
3. Atriums: Sensor with translucent dome with 180-degree field of view and respond in range of 10-1,000 foot-candles.
4. Skylights: Sensor with translucent dome with 180-degree field of view and respond in range of 10-1,000 foot-candles.

E. Programming for Dimmed Daylight Control
1. Manufacturer to program.

F. Programming for On/Off Daylight Control
1. Set off delay to 0 for programming, but adjust to 15 minutes after programming to avoid nuisance operation of the device.
2. Any lighting within the space that is not controlled by the sensor should remain on throughout the programming process.
3. At mid-day on a cloudless day, verify with a light meter that the required foot-candle levels are measured at the required location for each space with the lighting to be controlled by the sensor off.

4. If the required light levels are not present, return to site and repeat programming effort the following August. Coordinate visit with owner.
5. If required light levels are present, periodically check light levels on the following day, starting in the early morning, and program sensor when the required light levels first appear.
6. Turn lighting on and adjust dial until lights switch off.
7. Set office and work area sensor as follows
    a. Offices: 40FC measured at the working surface when the lighting controlled by the sensor is off.
    b. Open Offices: 40FC measured at the working surface of the cubicle furthest from the source of daylight (i.e. windows) and located between the source of daylight and the first row of lights not controlled by the daylight sensor.
8. Set sensors in other locations by measuring the following levels at floor level along the centerline of the space between the wall transmitting daylight and the outside edge of the first row of lights that will remain on after the daylight sensor controlled lights are switched off.
    a. Conference Rooms: 30FC
    b. Corridors: 20FC
    c. Lobbies: 20 FC
    d. Classrooms: 50FC
    e. Dinning: 30 FC
    f. Restrooms: 20FC

## PART 3 EXECUTION

### 3.1 EXAMINATION

A. Verify outlet boxes are installed at proper height.

B. Verify wall openings are neatly cut and completely covered by wall plates.

C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

D. Verify locations of floor boxes and outlets prior to rough in

### 3.2 PREPARATION

A. Clean debris from outlet boxes.

3.3 EXISTING WORK

A. Disconnect and remove abandoned wiring devices.

B. Modify installation to maintain access to existing wiring devices to remain active.

C. Clean and repair existing wiring devices to remain or to be reinstalled.

D. Maintain access to existing floor boxes remaining active and requiring access. Modify installation or provide access panel.

3.4 INSTALLATION

A. Install devices plumb and level.

B. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

C. Install boxes and fittings to preserve fire resistance rating of slabs and other elements

D. Connect wiring devices by wrapping solid conductor around screw terminal.
   1. Install stranded conductor for branch circuits 10 AWG and smaller.
   2. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations.
   3. Do not place bare stranded conductors directly under device screws.

E. Wall Plates
   1. Install wall plates on flush mounted switches, receptacles, and blank outlets.
   2. Install decorative plates with concealed screws on switches, receptacles, and blank outlets in finished areas.
   3. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
   4. Use jumbo size plates for outlets installed in masonry walls.

F. Switches
   1. Install switches with OFF position down.
   2. Where multiple switches are installed at the same location, switches shall be ganged together.

G. Dimmers
   1. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
   2. Do not share neutral conductor on load side of dimmers.
   3. Install dimmers on the load side of occupancy sensors and other controls.

H. Receptacles
1. Install receptacles with grounding pole on top.
2. Provide appropriate receptacle type for the application per the requirements listed in part 2 above.

I. Floor Boxes
1. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
2. Set floor boxes level with finished floor. Smooth any edges that protrude above finished floors
3. Provide a communications conduit with pull string from all floor boxes and poke throughs to the accessible ceiling on the level that the device serves or to the appropriate communications closet as required. Refer to plans for conduit size, 1" minimum.

J. Occupancy and photo sensors
1. Install ceiling mounted devices in center of area to be covered.
2. Install wall mounted devices at the typical switch location unless gimbal mounted.
3. Install gimbal mounted wall switches at 18" below ceiling.
4. Install 180-degree ceiling mounted devices at locations that are exposed to adjacent spaces from which false on signals could come.
5. Install gimbal mounted and 180-degree ceiling devices at edge of space facing towards the area to be covered and away from adjacent spaces from which false on signals could come

K. Relays
1. Mount relay as indicated on Drawings. Wire numbered relays in panel to control power to each load. Install relays to be accessible. Allow space around relays for ventilation and circulation of air.
2. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.
3. Label each low voltage wire with relay number at each switch or sensor

## 3.5 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes with furniture and equipment.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle 18 inches above finished floor.

D. Install convenience receptacle 6 inches above back splash of counter.

E. Install dimmer 48 inches above finished floor.

## 3.6 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch and occupancy sensor with circuit energized and verify proper operation.

C. Verify each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.7 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust floor box flush with finish flooring material

3.8 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

# SECTION 26 28 19 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes
   1. Fusible and nonfusible switches.
   2. Enclosed circuit breakers

### 1.2 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA FU 1 - Low Voltage Cartridge Fuses.
   2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   3. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.

B. International Electrical Testing Association:
   1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

### 1.3 SUBMITTALS

A. Shop Drawings: Manufacturer or contractor prepared drawings showing all relevant dimensions, weights, electrical and mechanical connection requirements, conduit entry points, assembly requirements, and required clearances.
   1. Include dimensioned plan views and elevations.
   2. Include all relevant electrical diagrams including schematic and interconnection diagrams for power, signal, and control wiring.

B. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
   1. Include amperage ratings, voltage, over-current protective device ratings, AIC ratings.
   2. Where multiple sizes are listed, indicate sizes to be used.
   3. Where multiple products are shown on the same page, indicate which products to be used.

### 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of electrical equipment and record actual circuiting arrangements.

B. Operation and Maintenance Data:
   1. Provide product data as defined under submittals.

2. Provide manufacturer's installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
3. Submit spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

## 1.5 QUALIFICATIONS

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

B. Supplier: Authorized distributor

C. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

## 1.6 QUALITY ASSURANCE

A. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.

B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

## 1.7 WARRANTY

A. Provide manufacturer's standard form clearly stating that manufacturer agrees to repair or replace equipment, materials, and associated auxiliary components that fail or deteriorate within the specified warranty period.

B. Warranty Period: one (1) year from the date of substantial completion

## 1.8 DELIVERY STORAGE AND HANDLING

A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.

B. Maintain factory wrapping or provide additional canvas or plastic cover for all large electrical equipment. Follow all manufacturer recommendations for humidity and max/min temperatures for storing electrical equipment.

PART 2 PRODUCTS

2.1 NONFUSIBLE AND FUSIBLE SWITCH ASSEMBLIES

A. Manufacturers:
1. GE Electrical
2. Square D
3. Eaton
4. Siemens
5. Substitutions: With engineer approval.

B. Product Description:
1. NEMA KS 1, Type HD
2. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
3. Defeater mechanism to allow opening energized disconnects 30A and smaller.
4. Enclosed load interrupter knife switch, quick make/quick break.
5. Handle lockable in ON and OFF position.
6. Fully hinged front cover.

C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.

D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel except that stainless steel shall be used for 4X enclosures
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.
3. Industrial Locations: Type 12
4. Corrosive Locations: Type 4X
   a. Pool pump rooms
   b. Chemical storage rooms
   c. Within 25 feet of cooling towers
   d. Other corrosive locations.

E. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

F. Furnish switches with entirely copper current carrying parts.

2.2 SWITCH RATINGS

A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.

B. Short Circuit Current Rating: UL listed for available fault current.

2.3 MOLDED CASE CIRCUIT BREAKER

A. Manufacturers:
1. GE Electrical

2. Square D
3. Eaton
4. Siemens
5. Substitutions: With engineer approval.

B. Product Description: Enclosed, molded-case circuit breaker conforming to NEMA AB 1, suitable for use as service entrance equipment where applied.

C. Field-Adjustable Trip Circuit Breaker:
1. For distribution breakers rated 400A or more, provide the following adjustable trip settings
   a. Long Time Trip
   b. Long Time Delay
   c. Short Time Trip
   d. Short Time Delay
2. For distribution breakers rated 800A or more, provide the following adjustable trip settings
   a. Long Time Trip
   b. Long Time Delay
   c. Short Time Trip
   d. Short Time Delay
   e. Instantaneous Trip
   f. Ground Fault Trip
   g. Ground Fault Delay

D. Field-Changeable Ampere Rating Circuit Breaker: Circuit breakers with frame sizes 1000 amperes and larger have changeable trip units.
1. Interlocks trip circuit breaker and prevent closing circuit breaker when limiter compartment cover is removed or when one or more limiter is not in place or has operated.

E. Accessories: Conform to NEMA AB 1.
1. Shunt Trip Device: 120 volts, provide for enclosed CBs serving elevators and at other locations as noted on plans.
2. Undervoltage Trip Device: 120volts, AC].
3. Auxiliary Switch: 120 volts, AC.
4. Alarm Switch: 120volts, AC.
5. Electrical Operator: 120volts, AC.
6. Handle Lock: Provisions for padlocking.
7. Insulated Grounding Lug: In each enclosure.

F. Enclosure: NEMA AB 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R
3. Corrosive Locations: Type 4X.

G. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

2.4 INSULATED CASE CIRCUIT BREAKER

A. Manufacturers:
1. GE Electrical
2. Square D
3. Eaton
4. Siemens
5. Substitutions: With engineer approval.

B. Product Description: Enclosed, insulated-case circuit breaker conforming to NEMA AB 1[, suitable for use as service entrance equipment where applied].

C. Service Conditions:
1. Altitude: 6,000 feet above sea level.

D. Trip Unit: Electronic sensing, timing, and tripping circuits for adjustable current settings; [ground fault trip with [integral ground fault sensing] [zero sequence type ground fault sensor]]; instantaneous trip; and adjustable short time trip.

E. Enclosure: NEMA AB 1, to meet conditions. Fabricate enclosure from [steel finished with manufacturer's standard gray.
1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned enclosed switches, starters and enclosed circuit breakers.

B. Maintain access to existing enclosed switches and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing enclosed switches to remain or to be reinstalled.

3.2 INSTALLATION

A. Install enclosed switches plumb. Provide supports in accordance with Section 26 05 29.

B. Height: 5 feet to operating handle.

C. Install fuses for fusible disconnect switches.

D. Install engraved plastic nameplates in accordance with identifications requirements in specifications and on plans.

E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.3 FIELD QUALITY CONTROL

A. Inspect each device for defects.

B. Operate each switch with circuit energized and verify proper operation.

C. Torque all terminations.

3.4 CLEANING

A. Construction Waste: In accordance with Section 01 74 19.

END OF SECTION

# SECTION 26 51 00 - LED INTERIOR LIGHTING

## PART 1 GENERAL

### 1.1 SUMMARY

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

B. Section includes LED luminaries, emergency lighting unit, exit signs, and exterior poles.

### 1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

### 1.3 SUBMITTALS

A. Product Data:
1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests.

a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.
a. Include plans, elevations, sections, and mounting and attachment details.
b. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Include diagrams for power, signal, and control wiring.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
   1. Manufacturer shall maintain or certify an independently operated service center capable of providing training, support, parts, and maintenance services.

B. Supplier: Authorized distributor

C. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work.

1.5 QUALITY ASSURANCE

A. Source Limitations: All components required for a complete functioning luminaire as described here in shall be obtained through one source from a single manufacturer.

B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.6 WARRANTY

A. Provide manufacturer's standard form clearly stating that manufacturer agrees to repair or replace equipment, materials, and associated auxiliary components that fail or deteriorate within the specified warranty period.

B. Warranty Period:
   1. Five (5) years from the date of substantial completion for all ballasts.

1.7 DELIVERY STORAGE AND HANDLING

A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.

B. Maintain factory wrapping or provide additional canvas or plastic cover. Follow all manufacturer recommendations for humidity and max/min temperatures for storing.

1.8 MAINTENANCE MATERIALS

A. Furnish two of each plastic lens type.

PART 2 PRODUCTS

2.1 LUMINAIRES

A. Manufacturers:
1. Manufacturers shall be as listed in the luminaire schedule
2. Substitutions: With engineer approval.

B. Product Description: Complete luminaire assemblies, with features, options, and accessories as scheduled.

2.2 LED Drivers

A. Product Description:
1. LED power supplies shall operate LEDs within the current limit specification of the manufacturer
2. UL Class 2 rated or similar, class 1 rated not acceptable
3. 60Hz input source
4. input power factor >90%
5. minimum efficiency of 70% at full rated load of the driver
6. Minimum starting temperature of 0°F
7. Maximum case temperature rating of at least 70°C
8. Power supply output regulated to +/-5% across published load rang
9. Class A sound rating
10. Compliant with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47CFR part 15, non-consumer (Class A) for EMI/RFI B
11. 3-year minimum warranty from date of manufacturer against defects in material or workmanship, including a replacement, for operation at or below the maximum case temperature specification. (For LED lamps and internal power regulation components for defects resulting in a fixture lumen depreciation >30%.)
12. Dimmable power supplies shall allow the light output to be maintained at the lowest control setting (prior to off) without dropping out
13. No PCBs

B. General Requirements
1. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.

3. Driver must limit inrush current.
   a. Base specification: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps2 – seconds.
   b. Preferred Specification: Meet or exceed 30mA2s at 277VAC for up to 50 watts of load and 75A at 240us at 277VAC for 100 watts of load.
4. Withstand up to a 1,000-volt surge without impairment of performance as defined by ANSI C62.41 Category A.
5. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
6. Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
7. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
   a. Adjustment of forward LED voltage, supporting 3V through 55V
   b. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
   c. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000-hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
8. Driver must be able to operate for a (+/- 10%)supply voltage of 120V through 277VAC at 60Hz.
9. Driver should be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.

C. Light Quality
1. Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0% relative light output, or 100 – 1% light output and step to 0% where indicated. Driver shall respond similarly when raising from 0% to 100%
2. Driver must be capable of 20-bit dimming resolution for white light LED drivers or 15-bit resolution for RGBW LED drivers.
3. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
4. Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
5. Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have:
   a. LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
   b. Base specification: Flicker index shall less than 5% at all frequencies below 1000 Hz.
   c. Preferred specification: Flicker index shall be equal to incandescent, less than 1% at all frequencies below 1000 Hz.

D. Control Input for LED Drivers
1. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
   a. Must meet IEC 60929 Annex E for General White Lighting LED drivers

b. Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
c. Must meet ESTA E1.3 for RGBW LED drivers

2. Digital (DALI Low Voltage Controlled) Dimming Drivers
a. Must meet IEC 62386

2.3 LED Lamps and Luminaires

A. Manufacturers
1. Lamps:
a. Philips
b. Substitutions: With engineer approval.
2. Luminaire Manufacturers shall
a. Provide the manufacturer's name of the LED being used in the luminaire
b. Meet DOE's Energy Star or Design Light Consortium performance criteria
c. Registered as a DOE Quality Advocate

B. Product Description
1. 50,000-hour rated
2. Minimum CRI 80
3. The CCT shall be 4000K
4. total harmonic distortion (THD) <10%
5. power factor ≥90%
6. Shall be tested in accordance with LM-79-08 electrical and photometric measurements. Provide to the owner test results of each unique lamp.
7. LED light source packages, arrays or modules used in the luminaire shall be tested in accordance with LM-80 lumen depreciation test. Provide to the owner, test results of each unique package, array or module. The L70 rated life result shall be a minimum of 50,000 hours
8. Luminaires shall be UL, or ETL, listed and be furnished complete with LEDs and power supplies
9. Minimum 3-year warranty covering all components.

2.4 EMERGENCY LIGHTING UNITS

A. Manufacturers:
1. Manufacturers shall be as listed in the luminaire schedule
2. Substitutions: With engineer approval.

B. Battery: nickel-cadmium, with 1.5-hour capacity.

C. Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.

2.5 EXIT SIGNS

A. Manufacturers:
1. Manufacturers shall be as listed in the luminaire schedule

2. Substitutions: With engineer approval.

B. Product Description:
1. Universally mountable, field selectable.
2. Finished areas: clear glass face with red letters
3. Mechanical rooms and industrial areas: Aluminum or steel stencil face with red letters.
4. Direction Arrows: universal type for field adjustment

C. Battery: 6 or 12 volts, nickel-cadmium type, with 1.5-hour capacity.

D. Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.

E. Lamps: LED 5 W per side, maximum.

F. Input Voltage: 120-277 volts.

## 2.6 METAL POLES

A. Manufacturers:
1. Provide pole by the manufacturer of the support luminaires
2. Substitutions: With engineer approval.

B. Product Description
1. Steel pole with finish to match luminaire or as noted on schedule
2. Provide square straight pole, unless noted otherwise.
3. Height: 25 feet unless noted otherwise on plans.
4. Base: Break-away type with 4 anchor bolts and cover plate

C. Accessories:
1. Handhole.
2. Ground rod in foundation.

D. Provide rebar re-enforced concrete foundation. Refer to plans for foundation detail

# PART 3 EXECUTION

## 3.1 EXISTING WORK

A. Disconnect and remove abandoned luminaires, lamps, and accessories.

B. Extend existing interior luminaire installations using materials and methods compatible with existing installations.

C. Clean and repair existing interior luminaires to remain or to be reinstalled.

## 3.2 PREINSTALLATION COORDINATION

A. Refer to architectural reflected ceiling plan for exact light fixture locations.

B. Examine the area of installation to verify adequate space and mounting provisions are provided for the specified luminaire prior to order luminaires.

C. Verify that luminaires will not interfere with required clearances for equipment such as HVAC equipment filter removal clearance, NEC working space in front of HVAC equipment control panels, etc.

D. Coordinate location of exit lights with structure and other MEP systems to ensure that exit signs are clearly visible.

## 3.3 INSTALLATION

A. Lighting Conductors and Conduit
   1. Provide ground wire and one neutral conductor per circuit in all lighting conduit.
   2. All conductors serving luminaires shall be routed in conduit.
   3. Luminaire whips may be flexible metal conduit up to 6ft. Secure to structure with listed supports.
   4. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

B. Label all circuit breakers serving emergency lighting

C. Install suspended luminaires using pendants supported from swivel hangers. Install pendant length required to suspend luminaire at indicated height.

D. Install luminaires plumb, square, and level and aligned with ceilings, walls, and with each other and secure per manufacturer's printed instructions.

E. Recessed Luminaire Requirements
   1. Install recessed luminaires to permit removal from below.
   2. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
   3. Install clips to secure recessed grid-supported luminaires in place.
   4. Support luminaires in grid ceiling independent of ceiling framing.

F. Battery Pack Installation
   1. Unless noted otherwise, lighting with battery packs is to be switched with the adjacent, similar room lighting.
   2. In addition to the switched circuit, provide an un-switched leg from the same circuit to all battery packs for battery pack sensing of power loss.
   3. Mount in an accessible location if not integral to luminaire.
   4. If a remote battery indicator light is provided, install flush in ceiling adjacent to fixture. Coordinate location with architect for lobbies, reception areas, public corridors, conference rooms, classrooms, and other spaces where aesthetic considerations are critical.
   5. Coordinate mounting location for remote test switch (if required) with architect.

G. Install wall-mounted luminaires at height as indicated on architectural drawings

H. Install accessories furnished with each luminaire.

I. Install specified lamps in each luminaire.

J. Site Lighting Requirements
   1. Install concrete bases for bollards, grade mounted landscape, building façade, flag pole lighting, and poles for site area lighting.
   2. Install poles plumb. Install shims to adjust plumb. Grout around each base.
   3. Obtain and follow manufacturer's template when installing anchor bolts for each luminaire to be installed on a concrete base.
      a. Install anchor bolts prior to concrete pour.
      b. Do not drill concrete base to install anchor bolts.
   4. Stub out a 1" conduit and cap below grade at the last concrete base on each lighting circuit.
   5. Provide and install ¾" x 10' ground rod at each concrete foundation supporting metal poles or structures containing electrical for lighting.

## 3.4 FIELD QUALITY CONTROL

A. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

## 3.5 ADJUSTING

A. Aim and adjust luminaires.

B. Position exit sign directional arrows as indicated on Drawings.

## 3.6 CLEANING

A. Remove dirt and debris from enclosures.

B. Clean photometric control surfaces as recommended by manufacturer.

C. Clean finishes and touch up damage.

D. Construction Waste: In accordance with Section 01 74 19.

## 3.7 PROTECTION OF FINISHED WORK

A. Relamp luminaires having failed lamps at Substantial Completion.

END OF SECTION

# SECTION 26 5583 - BROADCAST LIGHTING

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Luminaires (lighting fixtures) and accessories.
2. Distribution components and connector strips (“electrics”)
3. Wire and cable.
4. Lighting control system.
5. Desktop operator workstation.
6. Rigging components.
7. General requirements for installation of broadcast lighting systems.

### 1.2 DEFINITIONS

A. Channel: An individual control output on a control console, accessed and regulated by a slider, switch, or button; or in some cases, accessed by a discretely assigned address and regulated by a data input apparatus.

B. Control Voltage: As defined in NFPA 70, term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.

C. Fade Time: The time it takes all zones to fade from one lighting scene to another, with all zones arriving at the next scene at the same time.

D. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.

### 1.3 SYSTEM DESCRIPTION

A. A well-lit demonstration area will help ensure professional final results for Test Kitchen presentations. The overhead pipe grid in the kitchen will provide the bulk of the hanging positions for studio and theatrical lighting equipment lighting, and blackout shades will help limit ambient light from coming in from the patio area. All of the above will be able to be programmed and controlled from the control booth or via an iPad-based remote controller and/or a wall-mounted touch panel control surface.

B. Accent lighting highlighting kitchen backgrounds and side walls will also help contribute to the overall ambience of the space, and will be able to be programmed into theatrical lighting looks” as desired, or used for live mixers and events.

## 1.4 ACTION SUBMITTALS

A. Product Data:

1. Luminaires (lighting fixtures) and accessories.
2. Distribution components and connector strips (“electrics”)
3. Wire and cable.
4. Lighting control system.
5. Desktop operator workstation.
6. Rigging components.

B. Shop Drawings: For complete lighting system.

1. Include plans, elevations, sections, and mounting / attachment details.
2. Detail fabrication and installation for rigging, distribution components, dimming/relay panel(s); control/dimming rack(s) or cabinet(s); and arrangements, characteristics, and circuit assignments of various modules and rack- and cabinet-mounted accessories.
3. Elevation views of front, rear, and side panels indicating devices and controls, including illustrations and dimensioned outline drawings.
4. Wiring Diagrams: For power, signal, and control wiring. Show connections, circuits, and channel assignments.
5. Equipment Legend: Show a unified system of designations for lighting instruments, panels, dimmers, circuits, and equipment.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plan(s), and other details drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances for operation, maintenance, and environmental conditions.
2. Areas above and around dimming equipment where piping and ducts are prohibited.
3. Rack layout and relationships between components and adjacent structural and mechanical elements.

B. Qualification Data: For Installer.

C. Seismic Qualification Data: Certificates, for lighting equipment, distribution equipment, and rigging components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires, distribution components, software operating manuals, and controls to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Instructional USB Storage Drive(s) with Video File(s): Professionally produced informational presentation to provide comprehensive instructions for equipment installation, connectivity, programing, and functional use. Information provided shall be specific to equipment provided for Project and shall include ancillary equipment and its integration into the broadcast lighting control system. Refer to article “End User Training and Instruction” in Part 3 of this section.

b. Control-Console Introduction:

1) Descriptions of controls and features.

2) Software app instruction manuals.

3) Setup requirements for unit and related equipment.

4) Default settings.

5) Maintenance procedures and schedules.

c. Control-Console Operation:

1) Elementary on-off operation.

2) How to set cues manually.

3) How to patch dimmer to channels electronically.

4) How to operate presets manually.

5) How to operate fundamental memory.

6) How to set and record simple cues.

7) How to recall, play back, and revise cues and scenes.

8) How to use submasters, groups, focus points, fader channels; and how to split cues, store and recall programs, set up special effects, and print out cues.

9) How to set up and run system for a typical event or performance.

10) How to get help.

d. Relay Control Panel, Control Bus Hardware and DMX Hardware:

1) Descriptions of features, functions, and safety and security precautions.

2) Descriptions of control module/card features, software-driven functions, non-dim functions, and associated racking systems.

3) How to terminate basic power-in and power-out connections.

4) Basic maintenance requirements, including need for qualified electrician for internal maintenance; basic maintenance schedule; techniques for keeping

terminals properly tightened, filter screens clean, and overheat sensors checked; and techniques for performing other required servicing.

5) How to adjust -control modules and cards.

6) How to get help.

7) Description of warranty.

e. System Troubleshooting: Procedures for handling problems with common software, programming, control console, dimmer rack, and distribution system; include information on how to get help.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On USB drive, complete with data files.

3. Device address list if applicable.

4. Printout of software application and graphic screens.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Control Relays: One of each type and rating installed.

2. Required Accessories for Lighting Fixtures: One for every type installed. Furnish at least one of each type, including: C-clamp or mega claw, safety cable, PowerCon cable, and DMX.

3. Optical Accessories for Lighting Fixtures: One for every three of each type installed. Furnish at least one of each type, including: gobo/template holder, gel/filter frame, tophat, as applicable for each fixture.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

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

C. Comply with NECA 1.

D. Comply with NFPA 70.

## 1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of the complete lighting control system and luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Cost to repair or replace parts for two years from date of Substantial Completion.

## 1.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years from date of Substantial Completion.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to the Owner to allow scheduling and access to system and to allow the State to upgrade computer equipment if necessary.

# PART 2 PRODUCTS

## 2.1 MANUFACTURERS

A. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated on Drawings as manufactured by the following:

1. Lighting instruments/fixtures and accessories – provide by one or more of the following, subject to compliance with requirements indicated for each product:
    a. Electronic Theatre Controls (ETC)
    b. Vari-Lite (formerly Strand) by Signify (formerly Philips)
    c. Chauvet Professional
    d. Altman Lighting
    e. SGM Light A/S
    f. Elation Professional
2. Control electronics – provide by one or more of the following, subject to compliance with requirements indicated for each product:
    a. Electronic Theatre Controls (ETC)
    b. Vari-Lite (formerly Strand) by Signify (formerly Philips)
    c. ChamSys
3. Distribution components and connector strips ("electrics") - provide by one or more of the following, subject to compliance with requirements indicated for each product:

a. Electronic Theatre Controls (ETC)

b. Vari-Lite (formerly Strand) by Signify (formerly Philips)

c. The Light Source Inc.

4. Static rigging for connector strips (“electrics”) – provide by one or more of the following, subject to compliance with requirements indicated for each product:

a. Electronic Theatre Controls (ETC)

b. Vari-Lite (formerly Strand) by Signify (formerly Philips)

c. The Light Source Inc.

## 2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Dimmer racks 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."

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

C. Comply with NFPA 70.

## 2.3 LUMINAIRES (LIGHTING FIXTURES) AND ACCESSORIES

A. General:

1. Comply with UL 1573 and listed and labeled by an NRTL.

2. Luminaires: Equipped with pigtail, yoke with pipe clamp, safety cable for batten mounting, and filter holder.

3. Metal Parts: Free of burrs, sharp corners, and edges.

4. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

5. Luminaire Doors and Their Internal Access: Smooth operating, free of light leakage under operating conditions, and arranged to permit relamping without use of tools. Doors, lenses, diffusers, and other pieces arranged to prevent accidental falling during relamping and when secured in operating position.

6. Pigtail: Factory wired, 36-inch- long, three-wire cord and plug connector assembly with cord encased in woven fiberglass or silicone tubing.

7. Connector: Compatible with receptacle type(s) specified under Distribution Components.

8. Light Source: Integral Light Emitting Diode (LED) assembly.

9. Luminaire Ventilation Openings: Baffled against light leaks.

10. Luminaire Operating Controls and Handles: Thermally insulated.

11. Lenses: Borosilicate glass in silicone mountings.
12. Framing Shutters: Stainless steel, four way; with each blade in a separate plane under adjustable tension mounting. Blades adjust plus or minus 30 degrees of rotation in gate for 120-degree-minimum total angular rotation between adjacent blades.
13. Color Filter Frame Holder: Attached to front of luminaire.
14. Luminaire Yoke: Rigid metal, arranged for vertical aiming of unit and equipped with T-bolt or hand screw to lock alignment.

B. Specific Fixture Requirements: Refer to Luminaire Schedule on Drawings.

## 2.4 DISTRIBUTION COMPONENTS

A. Plug-in Boxes: Listed and labeled by an NRTL; factory-wired wireway and receptacle assembly, 8-16 inches long unless otherwise indicated; with the following features:

1. Wireway: Steel or extruded aluminum, with removable cover and nominal cross-section dimensions of 3 by 4-1/2 inches.
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable.
3. Receptacles:
   a. NEMA type 5-15R “Edison”.
   b. Flush mounted in wireway cover.
4. Receptacle Wiring: For connecting to terminal blocks; with 125 deg C, crosslinked, PE-insulated, identification-labeled wire.
5. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
6. Surface or Grid Mounting: With accessories for surface mounting or with pipe-mounting accessory bracket.
7. Recessed Mounting: With flanged cover suitable for recessed mounting in wall.
8. Finish: Semigloss or matte black.

B. Gridiron Junction Boxes: Listed and labeled by an NRTL; factory wired with terminal strips and concentric knockouts on all sides.

1. Terminal Blocks: Molded-barrier type with screw lugs to suit supply conductors.
2. Accessories: Cable clamps, support cradles, and cable strain relief grips for each cable; and brackets for surface or pipe mounting.
3. Finish: Semigloss or matte black.

## 2.5 WIRE AND CABLE

A. Building Wire in Raceways: Comply with requirements specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Portable Power Cable: Listed and labeled by an NRTL; flexible stage and lighting power cable; Type SC, SCE, or SCT; 600 V; multiconductor; 60 deg C temperature rating.

C. Ethernet Cabling: Comply with requirements specified in Section 260523 "Control-Voltage Electrical Power Cables."

1. For 10/100BaseT, comply with provisions for UTP cable and hardware.

D. ANSI E1.11 (USITT DMX512-A) Control Cabling: Comply with requirements specified in Section 260523 "Control-Voltage Electrical Power Cables."

1. Plenum-Rated Cable, NFPA 70 Type CMP:

a. Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, No. 24 AWG, stranded, tinned-copper conductors.

b. Inner Shield: 100 percent coverage, aluminum foil-polyester tape.

c. Outer Shield: 90 percent coverage, tinned-copper braid.

d. Outer Shield Drain Wire: Stranded, tinned copper.

e. Listed and labeled in accordance with UL 444.

f. Investigate insulation and jacket materials in accordance with UL 2257.

E. Control-Voltage Control Cabling:

1. Control-Cable Conductors:

a. Class 1 Control Circuits:

1) Conductor: Stranded copper, Type THHN-THWN, single-conductor wire complying with UL 83.

2) Method: In raceway.

b. Class 2 Control Circuits:

1) Conductor: Stranded copper, Type THHN-THWN, single-conductor wire complying with UL 83.

2) Method: In raceway.

c. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW complying with UL 83.

2. Plenum-Rated Cable, NFPA 70 Type CMP:

a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30), tinned-copper conductors.

b. Unshielded.

c. Listed and labeled in accordance with UL 444.

d. Investigate insulation and jacket materials in accordance with UL 2257.

## 2.6 WALL MOUNT RELAY PANEL AND LOAD CENTER

A. General:

1. Relay Panels shall be UL508, UL67, and UL924 Listed, and shall be so labeled when delivered.
2. Relay Panels shall consist of a main enclosure with (1) 24 pole breaker subpanel, relay/dimmer sub panel, integral control electronics, and a low voltage subpanel for data terminations and provision for accessory cards.
3. Up to three accessory cards shall be supported per relay panel.

B. Mechanical:

1. The panel shall be constructed of 16-gauge steel. All panel components shall be properly treated and finished in fine-textured, scratch resistant paint.
2. Relay panels shall be available in 120 and 277 Volt AC configurations.
    a. 120V enclosures shall be 67.5” high by 14.36” wide and 4” deep with a weight not more than 80 pounds.
3. The panel shall be wall-recessed mounted.
    a. 120VAC panels shall support mounting between standard wall stud framing (16-inch on center spacing).
4. Choice of panel covers shall be available for surface or recess mount applications. This outer panel shall ship complete with a locking door to limit access to electronics and breakers, breakers.
    a. Optional center-pin reject security screws shall be available for all accessible screws.
    b. Recess mount doors shall extend 1” beyond all panel edges to hide wall cut-out.
5. The unit shall provide interior cover over breaker panel to allow access only to class 2 wiring and prevent direct access to class 1 line voltage components.
6. Relays shall include integral switches for manual control while power is unavailable to the panel such that critical lighting can be set to an on state, without the need for power to the panel.
7. Relay output lugs shall accept 6-14AWG copper wire.
8. Breaker subpanel may include up to twenty-nine 20-amp single pole, up to fourteen 20 amp double pole, or nine three pole breakers as required in any combination up to capacity.
9. Control wiring for DMX, station bus, and Emergency input terminations shall land on removable headers for contractor installation.

C. User Interface:

1. The user interface shall contain a graphical display with button pad to include 0-9 number entry, up, down back arrow navigation and enter.
2. Test shortcut button shall be available for local activation of preset, sequence and set level overrides.
3. The user interface shall have a power status LED indicator (Blue), a DMX status LED indicator (Green), a network status LED indicator (Green) and an LED indicator (red) for errors.
4. Interface shall allow the backlight to timeout and shall provide user editable options to shut off backlight completely as well as adjust screen contrast.

5. Ethernet interface (when installed) shall default to automatic IP through link local and DHCP. Upon receiving IP address, the address of the Network Interface Card (NIC) shall display in the about menu. Static address and settings shall also be possible.
6. The control interface shall support a USB memory stick interface for uploads of configurations and software updates.

D. Functional:

1. Panel setup shall be user programmable. The control interface shall provide the following relay setup features (per circuit):
    a. Type (1 pole, 2 pole, or 3 pole)
    b. Name
    c. Circuit Number
    d. DMX address
    e. sACN address (network enabled panels only)
    f. Space Number
    g. Circuit Modes
        1) Normal (priority and HTP based activation and dimming)
        2) Latch-lock
        3) Fluorescent
        4) DALI
    h. On threshold level
    i. Off threshold level
    j. Include in UL924 emergency activation
    k. Allow Manual
2. Relay panels shall support discrete addressing of each relay. Panels that are restricted to use of start address with sequential addressing and cannot assign each 0-10V output control to any internal relay shall not be acceptable.
3. The panel shall be capable of switching all relays on or off at once, or in a user-selectable delay per relay using a period of 0.1 to 60 seconds, in 0.1 second increments.
4. Control electronics shall report the following information per branch circuit:
    a. Breaker state (On/Off)
    b. Relay state (Open/Closed)
    c. Current draw (In Amps)
    d. Voltage
    e. Energy usage
5. Built in Control shall include:
    a. Ability to record up to 16 presets in each space from the control panel, connected control stations, or timed events.

b. Presets shall be programmable by recording current levels (as set by DMX or connected control stations), by entering levels on the control panel directly, manually selecting relay state on each relay or a combination of these methods. From the control panel, stations, or timed events it shall be possible to record values for up to 16 zones per space.

c. Up to 8 spaces in a single rack for total of up to 16 spaces shall be supported per system or system subnet.

d. Indication of an active preset shall be visible on the control panel display.

e. One 16-step sequence per space for power up and power down routines.

1) Upon Data loss the system shall provide options to hold last look infinitely or hold for a configured time period set by the installing technician then fade/switch to the input of the next available priority.

f. Control electronics shall respond directly to control stations for zone, preset, and sequence control. Systems that require secondary control systems for this functionality are not acceptable.

g. After power loss, electronics shall be capable of holding the system in its previous state until new level data (DMX, architectural presets, sequences and zones, or local overrides) is received to make each relay change state.

6. The control of lighting and associated systems via real time and Astronomical clock controls.

a. The relay panel shall allow the activation of presets, sequence, and zone programming of up to 50 time clock events via a built in real and astronomical timeclock.

b. System time events shall be programmable via the control panel.

1) Time clock events shall be assigned to system day types. Standard day types include: everyday, weekday, weekend, Sunday, Monday, Tuesday, Wednesday, Thursday, Friday and Saturday.

2) Time clock events shall be activated based on sunrise, sunset, time of day or periodic event.

3) System shall automatically compensate for regions using a fully configurable daylight saving time.

4) Presets shall be assigned to events at the time clock.

5) The time clock shall support event override.

6) It shall be possible to override the timed event schedule form the face panel of the time clock.

c. The time clock shall support timed event hold.

1) It shall be possible to hold a timed event from the face panel of the processor.

7. The panel shall receive ESTA DMX512-A control protocol. Addressing shall be set via the user interface button keypad with any relay being patched to any DMX control address.

a. 2,500V of optical isolation shall be provided between the DMX512 inputs and the control electronics as well as between control and power components.

b. The relays shall respond to control changes (DMX or Stations) in less than 25 milliseconds. DMX512 update speed shall be 40Hz.

c. Setting changes shall be able to be made across all, some, or just one selected relay in a single action from the face panel.

d. DMX data loss shall allow for levels/relays to be held for ever or for a specified time before switching to a lower priority source.

e. Initial Panel setup

1) The relay panel shall automatically detect the type of relay or dimmer installed in each location without need for manual configuration of the physical arrangement.

2) Quick rack setup shall be available to apply address settings across all circuits for rack number, DMX Start Address, sACN universe, and sACN start address.

3) Emergency Setup Menu shall provide optional delays when emergency is activated or deactivated, and option to turn off non-emergency circuits shall be available. Record function shall allow circuits that are turned on to be added to the emergency setting.

E. Electrical:

1. Relay Panels shall be available to support power input from:

a. 120/208V three phase 4-wire plus ground.

2. Conduit Entry:

a. Feeders:

1) Top or top-side (upper 6” of either side)

2) Bottom or bottom-side 6” of either side

3) Feeders shall enter through the top or bottom according to the orientation of the enclosure.

4) Feeder entry shall be nearest to the location of the feeder lugs or main breaker.

b. Load:

1) Load wiring shall enter through the top or bottom of the enclosure.

2) Load wiring shall enter through the top/bottom surface nearest to the breaker sub panel.

3) Load wiring may also enter through left and/or right side provided a low voltage chase is not required through the same area. If class 2 chase is required, a field installable barrier panel shall be provided upon request. When installed, the left or right side of the panel, where the barrier has been installed, shall not permit load wiring.

c. Low Voltage:

1) Top or top-side (upper 6” of either side)

2) Bottom or bottom-side (bottom 6” of either side)

3) For low voltage conduit entry at the relay end of the cabinet, conduits shall be located at the outer 3” of the top/bottom panel.

4) Field installed low voltage channel shall be provided separately for installation on the left or right side of the panel to allow class 2 wiring to traverse the panel from top to bottom or bottom to top.

F. All relays shall be mechanically latching.

G. The relay shall be capable of switching 20A at up to 300V.

H. The relay panel shall support a maximum feed size of 200 Amps .

I. Relay panels shall support main circuit breaker options:

1. Main breaker options shall be optional and available for purchase upon request.
2. Main breakers shall be field installable.
3. Main breakers shall be available in 100 and 200 Amps for 120V systems and 150 Amps for 277V systems .
4. Series rated SCCR ratings apply as follows with appropriate main breaker:
5. 10,000A, 22,000 or 42,000 at 200A; 120/208V
6. Main breakers shall allow the following range of wire sizes:
7. 3/0 to 300kcmil at 120/208V

J. Relay

1. Each relay shall have a manual override switch with on/off status indication.
2. Relays shall be rated for use with:
   a. 16A Electronic Ballast loads @ 120, 240 and 277V.
   b. 20A Tungsten loads at 120, 240, and 277V.
   c. 20A 277V Ballast (HID).
   d. Motor loads with ratings of 20 FLA @ 120V, 17 FLA @ 240V, and 14 FLA @ 277V 100,000A symmetrical SCCR
3. Isolation shall be 4000V RMS.
4. Relays shall be latching state.
5. Rated Life:
   a. 1,000,000 mechanical activations.
   b. 100,000 cycles at full resistive load.
   c. 30,000 cycles full motor, inductive, tungsten, and electronic (LED).
   d. Decreasing loading shall increase the rated life of the relay inversely proportional the square of the load.
6. Relays shall support reporting of current usage with an accuracy of five percent of the connected load.

K. Relay Panel Accessories

1. An Ethernet option shall provide advanced control of relays over streaming ACN (sACN) and transmit status, control override, and measured energy usage per branch circuit to a web browser based or central monitoring interface.
2. A low voltage 0-10V dimming option shall provide up to 24 0-10v control outputs that are linkedto relay circuits within the panel. Each output shall support up to 400mA of current sink per output.
3. A contact input option shall provide 24 dry contact inputs to be linked for direct or group relay control, to activate a preset, or to activate a sequence. Controller software shall allow for normally open maintained, normally closed maintained, or momentary toggle.
4. A DALI control option shall provide 24 control loops of broadcast DALI control, with each loop controlling up to 64 DALI devices.
5. A RideThru option shall provide short-term power backup of control electronics by automatically engaging when power is lost, and recharging when normal power is present.
6. A tamperproof hardware kit shall be available that provides center reject Torx head screws to prevent access to panel interior by unqualified individuals.
7. Main Breaker options shall be available as specified.

L. Thermal

1. The panel shall be convection cooled. Panels that require the use of cooling fans shall not be acceptable.
2. The panel shall operate safely in an environment having an ambient temperature between 32ºF (0ºC) and 104ºF (40□C), and humidity between 5-95% non-condensing.

## 2.7 CONTROL SYSTEM

A. TBD.

B. I/O Gateway: TBD

C. DMX Opto-Splitter: TBD

D. Ethernet Switch: TBD

E. Ethernet Patch Panel: TBD

F. Accessories: TBD

## 2.8 ARCHITECTURAL CONTROL WALL STATIONS

A. House Lighting Control Station: Architectural-type, multichannel, remote-dimmer-control station with the following features:

1. System controls designated houselights, stage lights, and other lights.
2. Stage lighting controls compatible with dimming and control system.
3. Flush mounting.

4. Four channels, each with slider potentiometer control.
5. Master-slider potentiometer that controls lights on all channels proportionally from completely dimmed to degree of brightness that corresponds to individual slider positions.
6. Take-control/off switch that places station in control of channels and sets lighting to levels dictated by channel and master-slider controls.
7. Legend on face of wall plate that identifies items as "House Lighting Control Station" and identifies functions of each slider and switch position, with slider positions individually graduated from zero to maximum.
8. Illuminated push buttons for activating preset scenes of house lighting and labeled "Entry.", "General", "Clean".
9. Flush wall mounted unless otherwise indicated.

B. Entry Station: Push button activates or deactivates indicating light and presets scene of house lighting control system.
1. LED indicating light illuminates when preset command is executed.
2. Labeled "Entry."
3. Flush wall mounted unless otherwise indicated.

C. Recess flush wall mounted unless otherwise indicated.

## 2.9 CONTROL CONSOLE

A. Control Console: Tabletop unit with manual and portable tablet or computer-based programming controls, memory units, indicating devices, and the following features:
1. Grand-master level control.
2. Blackout switch.
3. Multiple submaster level controls with overlapping pile-on performance.
4. Bump buttons for momentary control of channels or submasters, one for each submaster level control.
5. Two cross-fade controls for split dipless fade between scenes, each with its own fade progress indicator.
6. One set of scene level controls for each scene when used in two-scene preset mode. Second set of scene level controls to allow setting levels into memory for expanded single scenes when used in multiple single-channel scene mode. Each set shall have same quantity of scene level controls as is used for submaster level controls.
7. Multibutton keypad for programming in multiscene memory mode.
8. Fade time control for assigning fade time to cues, with individual cue adjustment from one second to five minutes, minimum.
9. Digital display, for operating menus and memory readout.
10. Controls for setting levels into memory.
11. Cord and connector for connecting console to outlets for console power and control.

B. System Operation: Selectable between multichannel two-scene preset and four-channel single-scene memory. Console features include electronic patching of control signals for up to 512 dimmers and off-line data storage using USB drive port. Operational capability includes the following:

1. Live and blind programming.
2. Special effects programmability for automatic operation of lights in pulsating, sequential dimming and brightening, and other special operating modes. Special effects menu displays operator guidance for programming and individual step levels.
3. Signal from fire-alarm control panel that automatically brings selected circuits to fully on or fully bright condition, overriding normal dimming and on-off controls.
4. Inserting cues between designated cues without renumbering.
5. Out-of-sequence playback of cues.
6. Controlling houselights and stage lights from console by assigning their dimmers or non-dim on-off controls to a channel.
7. Retaining programmed cues in memory for minimum of one year after power outage.
8. Automatic sequential execution of programmed cues.
9. Printing cues using parallel or serial printer port, cable, and printer. Cable and printer are not included with this system.

C. Console Power and Control Outlets: Multiple receptacles matched to connector on console connector cord.

## 2.10 RIGGING COMPONENTS

A. Pipe Clamps: Malleable iron, suitable for clamping luminaires or items to pipe from 3/4 to 2 inches in OD. Arranged for horizontal rotation of yoke for aiming; equipped with T-bolt to lock alignment.

B. Safety Cables: Heavy-duty, flexible steel; 30-inch nominal length, with spring clip at one end and steel ring at the other end.

C. Cable Grips: Galvanized steel; basket-weave type for supporting stage cables.

D. <Insert accessories>.

# PART 3 EXECUTION

## 3.1 INSTALLATION

A. Comply with NECA 1.

B. Set permanently mounted items level, plumb, and square with ceilings and walls.

C. Indicated mounting heights are to bottom of unit for suspended items and to center of unit for wall-mounted items.

D. Mount and connect luminaires, and install and connect distribution devices.

1. If arrangement is not indicated, install so each luminaire, dimmer, house lighting circuit, control channel, and outlet circuit can be operated, and complete system demonstrated, in all operating modes.

2. Install safety cables secured to rigging or overhead structure for all pipe-mounted electrical luminaires and equipment.

E. Comply with mounting and anchoring requirements specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548.16 "Seismic Controls for Electrical Systems."

## 3.2 RIGGING

A. Installation of this equipment shall only be performed by approved and trained theatrical rigging installers. Installation shall be performed in a workmanlike manner and shall strictly adhere to the standards of these specifications and manufacturer's installation requirements. Where necessary, the installer may make adjustments to accommodate unforeseen impediments to installation. The completed work must achieve all electrical, safety and appearance requirements as established in these specifications.

B. Work shall be performed in accordance with OSHA and local codes.

C. On site welding shall only be performed per AWS D1.1 standards and with advanced approval from the architect or Owner's representative.

D. Division of Responsibilities:

1. The Rigging contractor shall be responsible for providing and installing:

   a. Pipe battens attached to Hanger Brackets

   b. Batten end caps

   c. Batten labels

2. The Electrical contractor shall be responsible for providing and installing:

   a. All pipe, wiring and termination providing line voltage to all the Power and Control End-Feed / Distribution boxes

   b. All pipe and wiring and all terminations of line voltage of dimmed and non-dimmed circuits that terminate at the termination / end-feed / distribution boxes mounted on/near the electric distribution strips and/or pipe battens.

## 3.3 WIRING

A. Power Wiring:

1. Install wiring as specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for hardwired connections. Install wiring in raceways except cable and plug connections. Install cable strain relief device on power and control cable drops.
2. Install power wiring with a separate neutral for each output circuit from relay panel.

B. Signaling, Remote-Control, and Power-Limited Circuits:

1. Comply with requirements specified in Section 260523 "Control-Voltage Electrical Power Cables" for installation of wiring. Install wiring in raceways except cable and plug connections.
2. Comply with the following unless otherwise indicated:
   a. Size conductors according to lighting control device manufacturer's written instructions.
   b. Select cable insulation, shielding, drain wire, and jacket complying with lighting control device manufacturer's written instructions.
   c. Install circuits to eliminate RFI and electromagnetic interference.
3. Remote-control circuits associated with emergency lighting control shall be installed complying with Class 1 circuit standards in NFPA 70.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes and in terminal cabinets and equipment enclosures.

E. Remove wall plates and protect devices and assemblies during painting.

F. Support luminaires, distribution components, and accessories as specified in Section 260529 "Hangers and Supports for Electrical Systems." Equip all pipe-mounted equipment with safety cables that are secured to supporting pipe.

G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

## 3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

B. Label each luminaire, lighting outlet, distribution device, and dimmer module with unique designation. Labels on elevated components shall be readable from the floor.

## 3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

2. Visual and Mechanical Tests and Inspections:
   a. Inspect each luminaire, outlet, module, control, and device for defects, finish failure, corrosion, physical damage, labeling by an NRTL, and nameplate.
   b. Exercise and perform operational tests on mechanical parts and operable devices according to manufacturer's written instructions.
   c. Check tightness of electrical connections with torque wrench.
   d. Verify proper protective device settings, fuse types, and ratings.
   e. Record results of tests and inspections.
3. Electrical Tests: Perform tests according to manufacturer's written instructions.
   a. Continuity tests of circuits.
   b. Operational Tests: Connect each outlet to a luminaire and a dimmer output circuit, so each dimmer module, dimmer-control and output circuit, outlet, and luminaire in a typical operating mode will be sequentially tested. Set and operate controls to demonstrate luminaires, outlets, dimmers, and controls in a sequence that cues and reproduces actual operating functions for a typical system of the size and scope installed. Include operation and control of houselights and stage lights from each control location and station, including optional plug-in, control-console outlet locations. Record luminaire and outlet assignments, control settings, operations, cues, and observations of performance.

B. Prepare test and inspection reports.
   1. Prepare a schedule of lighting outlets by number; indicate circuits, dimmers, connected luminaires, and control-channel assignments. Prepare a schedule of control settings and circuit assignments for house control channels. Prepare written reports of tests and observations. Report defective materials, workmanship, and unsatisfactory test results. Include records of repairs and adjustments made.

## 3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

B. Modify the software programming as required to comply with the Contract Documents.

## 3.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

## 3.8 END USER TRAINING AND INSTRUCTION

A. Engage a factory-authorized service representative to train Owner's staff to adjust, operate, and maintain stage lighting equipment.

1. Training shall be two four-hour sessions.
2. Include costs associated with the training with the equipment installation.
3. Provide a 14-day notice to Owner prior to scheduling training period.
4. Training sessions must be video-recorded by the Contractor and delivered in duplicate (2) copies on portable, external USB 3.2 flash drives with USB-C connector; “Sandisk Extreme Portable SSD” series (500 GB minimum storage capacity). Contractor will supply the equipment necessary to record all training sessions. Contractor shall provide a reasonable amount of post-editing of said video recordings after the training sessions to: crop any unnecessary segments; perform audio track compression (so that the audio is all within a reasonable dynamic range without too many extreme soft or extreme loud segments); perform audio track normalization (to set the mean audio level to a reasonably-loud setting; and to render the recording to high-quality yet reasonably-small video container files without excessive file compression artifacts. After performing post-editing and rendering of the training video file(s), the Contractor shall provide two (2) electronic copies to the Owner (contained on Qty.2 USB flash drives) to the Owner.

**END OF SECTION**

# SECTION 27 0500 – COMMON WORK RESULTS FOR COMMUNICATIONS

## 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 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

I. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

J. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

K. Division 27, Section 27 1543 Communications Faceplates and Connectors.

### 1.3 SUMMARY

A. Section Includes:

1. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
3. Sleeve seals.
4. Grout.
5. Common communications installation requirements.

## 1.4 GLOSSARY

| | | |
|---|---|---|
| A. | ANSI | American National Standards Institute |
| B. | ASME | American Society of Mechanical Engineers |
| C. | ASTM | American Society for Testing Materials |
| D. | BFU | Board of Fire Underwriters |
| E. | BICSI | Building Industry Consulting Services International |
| F. | CSA | Canadian Standards Association |
| G. | DEC | Department of Environmental Conservation |
| H. | EIA | Electronics Industry Association |
| I. | EPDM: | Ethylene-propylene-diene terpolymer rubber. |
| J. | ER | Equipment Room |
| K. | FCC | Federal Communications Commission |
| L. | FM | Factory Mutual |
| M. | IEEE | Institute of Electrical and Electronics Engineers |
| N. | ISD | Information Systems Division |
| O. | ISO | International Standards Organization |
| P. | LB | Electrical Elbow with accessible coverplate |
| Q. | NBR: | acryloNitrile-Butadiene Rubber. |
| R. | NEC | National Electrical Code |
| S. | NEMA | National Electrical Manufacturers' Association |
| T. | NESC | National Electrical Safety Code |
| U. | NFPA | National Fire Protection Association |
| V. | OSHA | Occupational Safety and Health Administration |
| W. | RUS | Rural Utility Service (formerly REA) |
| X. | TIA | Telecommunications Industry Association |
| Y. | UFBC | Uniform Fire Prevention and Building Code |

Z. UL Underwriter's Laboratories, Inc.

## 1.5 DEFINITIONS

A. Throughout the specifications, abbreviations may be used. The following are brief definitions of many of those abbreviations.

1. Approved / Approval: Written permission to use a material or system.
2. As Called for: Materials, equipment including the execution specified/shown in the Specifications.
3. Code Requirements: Minimum requirements.
4. Concealed: Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
5. Exposed: Work not identified as concealed.
6. Final Acceptance: Owner acceptance of the project from Contractor upon certified by Owner's Representative.
7. Furnish: Supply and deliver to installation location.
8. Furnished by Others: Receive delivery at job site or where called for and install.
9. Inspection: Visual observations by Owner or Owner's Representative.
10. Install: Mount and connect equipment and associated materials ready for use.
11. Listed: Refers to classification by a standards agency.
12. Or Approved Equal: Approved equal or equivalent as determined by Owner or Owner's Representative.
13. Owner's Representative: Design professional or Consultant representing the Owner.
14. Provide: Furnish, install and connect ready for use.
15. Relocate: Disassemble, disconnect and transport equipment to new locations; then clean, test and install ready for use.
16. Replace: Remove and provide new item.
17. Review: A general contractual conformance check of specified products.
18. Satisfactory: As specified in Specifications.

## 1.6 SUBMITTALS

A. Product Data: For sleeve seals.

## 1.7 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

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

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

## PART 2 - PRODUCTS

### 2.1 SLEEVES FOR PATHWAYS AND CABLES

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

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

### 2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
   e. Other approved equal

2. Sealing Elements: interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.

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

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

## 2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## 2.4 FIRE STOPPING

A. Fire stopping for openings through fire-rated and smoke-rated walls and floor assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire Stops" designated ASTM E814.

B. Inside of all conduits, the fire stop system shall consist of dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming or backer materials (where required). The sealant must be capable of being removed and reinstalled and must adhere to all penetrants and common construction materials and shall be capable of allowing normal wire/cable movement without being displaced.

C. All conduit and sleeve openings used by the Contractor shall be waterproofed or fireproofed in compliance with State and Local Building and Fire Codes. Strict adherence to National, State, and Local Fire Codes, particularly fire stopping will be required.

D. The Contractor shall patch all openings remaining around and inside all conduit, sleeves and cable penetrations to maintain the integrity of any fire rated wall, ceiling, floor, etc. The fire stop system shall consist of a dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming materials (where required). The sealant must be capable of being removed and reinstalled and must adhere to all penetrants and common construction materials and shall be capable of allowing normal wire/cable movement without being displaced.

E. All building conduits and sleeves installed and/or used under this Specification shall be fire stopped, or re-fire stopped, upon cable placement through such passageways.

F. Manufacturer's recommended installation standards must be closely followed (i.e. minimum depth of material, use of ceramic fiber and installation procedures).

## PART 3 - EXECUTION

### 3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

### 3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 4 inches (100 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work. Prior to installation, verify existing warranty of roof with CNM ITS and Plant Facility personnel.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals. Ensure installed sleeve is sloped towards outside to prevent rain/snow water seepage through pipe.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

## 3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.4 FIRESTOPPING

A. Fire stopping for Openings through Fire and Smoke Rated Wall and Floor Assemblies:

1. Provide materials and products listed. The system shall meet the requirements of "Fire Tests of Through-Penetration Fire Stops" designated ASTM E814. To be used inside all conduits and sleeves. Caulk on exterior of conduit penetration.
2. Provide fire stop system seals at all locations where conduit, fiber, cable trays, cables/wires and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire stop seal between sleeve and wall for drywall construction.
3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire stop system. The installation shall provide an air and watertight seal.
4. The methods used shall incorporate qualities that permit the easy removal or addition of conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating. Typical rating:
    a. floors - 3 hours
    b. corridor walls - 2 hours

c. offices - ¾ hour

d. smoke partitions - ¾ - 1 hour

5. Provide fire stop pillows for existing cable tray penetrations through firewalls.

**END OF SECTION**

# SECTION 27 0526 – GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0528 Pathways for Communication Systems.

C. Division 27, Section 27 0536 Cable Trays for Communications Systems.

D. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

E. Division 27, Section 27 0553 Identification for Communication Systems.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

### 1.3 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbar.
4. Grounding rods.
5. Grounding labeling.

## 1.4 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. EMT: Electrical metallic tubing.

C. TGB: Telecommunications grounding busbar.

D. TMGB: Telecommunications main grounding busbar.

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

## 1.6 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For Installer, installation supervisor, and field inspector.

C. Qualification Data: For testing agency and testing agencies field supervisor.

D. Field quality-control reports.

## 1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Result of the ground-resistance test, measured at the point of BCT connection.
   b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. 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.

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

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

## 1.9 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-B.

### 2.2 CONDUCTORS

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

1. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor and 1/4 inch, (6.3 mm), in diameter.
5. Bonding Conductor No. 6 AWG, stranded conductor.

6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

## 2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

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

1. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.
3. Harger Lightning and Grounding.
4. Panduit Corp.
5. Tyco Electronics Corp.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solder-less compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch, (15.8- or 25.4-mm), centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

## 2.4 GROUNDING BUSBARS

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

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches, (6.3 by 100 mm), in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA/EIA-607-B.

1. Predrilling shall be for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50mm), in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467 and shall comply with TIA/EIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch, (50-mm), clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards and impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbar: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467 and complying with TIA/EIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.

2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

3. Rack-Mounted Vertical Busbar: 72 or 36 inches, (1827 or 914 mm long, with), stainless-steel or copper-plated hardware for attachment to the rack.

## 2.5 GROUND RODS

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

1. Harger Lightning and Grounding.

2. Tyco Electronics Corp.

B. Ground Rods: Copper-clad, Zinc-coated, Stainless steel, sectional type, 3/4 inch by 10 feet, (19 mm by 3 m), 5/8 by 96 inches, (16 by 2400 mm), in diameter.

## 2.6 LABELING

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

1. Brother International Corporation.

2. HellermannTyton.

3. Panduit Corp.

B. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives and inks used by label printers.

C. Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA/EIA-607-B.

### 3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare tinned- copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm.)

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.

2. Install without splices.

3. Support at not more than 36-inch (900-mm) intervals.

4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

## 3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMBG and the ac service equipment ground shall not be smaller than No. 3/0AWG.

## 3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches, (50 mm), minimum from wall and 12 inches, (300 mm), above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

## 3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pre-twist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs and the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot, (1 sq. mm/linear meter), of conductor length and up to a maximum size of No. 3/0 AWG 168 kcmils, (85 sq. mm), unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted or vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB utilizing No. 6 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA/EIA-568-C.1 and TIA/EIA-568-C.2 when grounding screened, balanced, twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.

## 3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "ts-TMGB," where "ts" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "ts-TGB," where "ts" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

## 3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended in the BICSI TDMM. Conduct tests with the facility in operation.

   a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

   a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

**END OF SECTION**

# SECTION 27 0528 – PATHWAY FOR COMMUNICATIONS SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0536 Cable Trays for Communications Systems.

D. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

E. Division 27, Section 27 0553 Identification for Communication Systems.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

### 1.3 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Boxes, enclosures, and cabinets.
5. Hand holes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 0533 "Raceways and Boxes for Electrical Systems" for conduits, wire ways, surface raceways, boxes, enclosures, cabinets, hand holes, and faceplate adapters serving electrical systems.
2. Section 28 0528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, inner duct, boxes, and faceplate adapters serving electronic safety and security.
3. Section 27 0536 “Cable Trays for Communication Systems”

## 1.4 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wire ways and fittings.
3. Tele-power poles.
4. Boxes, enclosures, and cabinets.
5. Underground hand holes and boxes.

B. Sustainable Design Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. 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.

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

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

## 1.6 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## 1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS AND FITTINGS

A. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with TIA-569-C.

B. EMT: Comply with ANSI C80.3 and UL 797.

C. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2. Fittings for EMT:

a. Material: Steel or die cast.

b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions, where installed and including flexible external bonding jumper.

D. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies and compounded for use to lubricate and protect threaded conduit joints from corrosion, to enhance their conductivity.

E. Flexible Conduit will not be permitted.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

A. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

2. Comply with TIA-569-C.

B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Continuous HDPE: Comply with UL 651B.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway, approved for plenum riser or general-use installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with TIA-569-C.

## 2.4 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-C.

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

1. Cooper B- Line System #781011 04762
   #781011 04874
   #781011 04770
   #781011 04875

2. Erico Caddy Cat HP System

3. Erico Caddy Cat CM System

4. Owner or Consultant approved equal.

E. Galvanized or stainless steel.

F. J shape.

## 2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-C.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

B. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy aluminum, Type FD, with a gasketed cover.

C. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

D. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable, Semi-adjustable.
3. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) or 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep).

H. Gangable boxes are prohibited.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Coordinate "Hinged-Cover Enclosures" Paragraph below with Drawings if hinged cover enclosures other than NEMA 250, Type 1 are required, such as for very dusty areas; or if consideration should be given to use of NEMA 250, Type 3R or Type 12 enclosures.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 and Type 12, (dependent on environmental conditions), with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures: Plastic or fiberglass, finished inside with radio-frequency-resistant paint.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1, Type 3R, Type 12, (dependent on environmental conditions), galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panel boards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

## 2.6 PRECAST CONCRETE HANDHOLES AND BOXES

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

1. Christy Concrete Products.

2. Elmhurst-Chicago Stone Co.

3. Oldcastle Precast Group.

4. Rinker Group, Ltd.

5. Riverton Concrete Products.

6. Utility Concrete Products, LLC.

7. Utility Vault Co.

8. Wausau Tile Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of hand hole or box.

1. Retain one of four "Frame and Cover" subparagraphs below; revise to specify features of frame and cover assembly. Consult manufacturers for additional frame and cover designs.

2. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

a. Cover Hinges: Concealed, with hold-open ratchet assembly.

b. Cover Handle: Recessed.

3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

4. Cover Legend: Molded lettering, "COMMUNICATIONS."

5. Configuration: Units shall be designed for flush burial and have closed bottom with centered 12” diameter hole for drainage.

6. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

   a. Extension shall provide increased depth of 12 inches (300 mm).

   b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

7. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

8. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

   a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of hand holes, but close enough to corners to facilitate racking of cables on walls.

   b. Window opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.

   c. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.

9. Duct Entrances in Hand hole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

   a. Type and size shall match fittings to duct or conduit to be terminated.

   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of hand holes to facilitate racking of cable.

10. Hand holes 48 inches wide by 48 inches long (1200 mm wide by 1200 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Hand holes and Boxes:

1. Boxes and hand holes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.

3. Comply with TIA-569-C.

4. Hand holes/Manholes shall be traffic rated when installed in parking lots, access roads and streets.

B. Polymer-Concrete Hand holes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open, closed, integral closed, bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and hand hole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "COMMUNICATIONS."

## PART 3 - EXECUTION

### 3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: EMT, RNC, Type EPC-40-PVC, RNC and Type EPC-80-PVC.
2. Concealed Conduit, Aboveground: EMT, RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC Type EPC-80-PVC, direct buried concrete encased.
4. Boxes and Enclosures, above ground: NEMA 250, Type 3R Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT, RNC identified for such use.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT RNC, Type EPC-40-PVC or inner duct.
4. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway, EMT.
5. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway. Riser-type, communications-cable pathway EMT.
6. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway Riser-type, optical-fiber-cable pathway. Plenum-type, optical-fiber-cable pathway. General-use, communications-cable pathway. Riser-type, communications-cable pathway. Plenum-type, communications-cable pathway. EMT.
7. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel nonmetallic in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 1 inch (27mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use setscrew or compression, steel and cast-metal fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg. F, (49 deg. C).

## 3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-C for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 1 inch, (25 mm), of concrete cover in all directions.
4. Do not embed thread less fittings in concrete unless specifically approved by Architect for each specific location.

H. Stub-ups to Above Recessed Ceilings:

1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

I. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

J. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

K. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

M. Spare Pathways: Install pull wires in empty pathways. Cap underground pathways designated as spare above grade alongside pathways in use.

N. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.

O. "Pathways for Optical-Fiber and Communications Cable" Paragraph below is applicable for EMT, RMC, RNC, and optical-fiber and communications-cable pathways.

P. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:

1. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.

Q. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound.

R. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

S. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg. F, (17 deg. C) and that has straight-run length that exceeds 25 feet, (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg. F, (55 deg. C) and that has straight-run length that exceeds 100 feet, (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg. F, (70 deg. C), temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg. F, (86 deg. C), temperature change.

c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg. F, (70 deg. C), temperature change.

d. Ceilings and Attics: 135 deg. F, (75 deg. C), temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg. F, (0.06 mm per meter of length of straight run per deg. (C), of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg., F, (0.0115), mm per meter of length of straight run per deg., ( C), of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

T. Mount boxes at heights indicated on Drawings in accordance with ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

U. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

V. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.

2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.

3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.

4. Space hooks no more than 4 feet (1.5 m) o.c.

5. Provide a hook at each change in direction.

## 3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 2000 "Earth Moving" for pipe less than 6 inches, (150 mm), in nominal diameter.

2. Install backfill as specified in Section 31 2000 "Earth Moving."

3. After installing conduit, backfill and compact. After placing controlled backfill to within 12 inches, (300 mm), of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 2000, "Earth Moving."

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches, (75 mm), of concrete for a minimum of 12 inches, (300 mm), on each side of the coupling.

   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches, (1500 mm), from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

## 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install hand holes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch, (25 mm), above finished grade.

C. Install hand holes with bottom below frost line, in accordance with manufacturer’s specifications.

D. Field cut openings for conduits according to enclosure manufacturer's written instructions.

## 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 0544, "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

## 3.6 FIRESTOPPING

A. Install fire stopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413, "Penetration Fire stopping."

## 3.7 SPECIAL CONDITIONS

A. All Animal Holding, Behavior and Anterooms device boxes shall be cast type. Where device boxes and conduits are recessed mounted, the box to the adjacent wall, ceiling of floor surface shall be sealed. All wiring shall be provided in either threaded RGS, IMC (when recessed), or

electrical metallic tubing when recessed and with compression fittings. Once wiring is installed, the wiring shall be surrounded by a one inch barrier of silicone caulking around the conductors within the device box hub. Gasketed device cover plates shall be used, with an additional continuous bead of silicone caulk between the device plate and the adjacent wall, ceiling, or floor surface. Where device boxes and conduits are surface mounted, and where the device box meets the wall, ceiling, or floor surface, a continuous bead of silicon caulk shall be provided. No recessed conduits are then required to be threaded RGS on minimum ¾: standoffs, or if also surface mounted, both sides of the conduit shall be sealed to adjacent surfaces with silicone caulk. This prevents vermin harborage in and transmission through the electrical systems.

## 3.8 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION**

# SECTION 27 0536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes: Contractor is responsible for providing and installing a complete Cable tray system that meets or exceeds the specifications listed below.

1. Ladder cable trays, Contractor is to install cable trays within the ER/TR's.
2. Wire-basket cable trays. Contractor is to install all cable trays outside of the ER/TR,s

B. Related Requirements:

1. Section 27 0500 Common Work Results for Communications.

### 1.3 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

E. Division 27, Section 27 0553 Identification for Communication Systems.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to sides of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. 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.

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

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

## 1.6 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## 1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.

2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Seismic Qualification Data: Certificates, for cable trays, 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. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5, 1.0.

### 2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

## 2.3 LADDER CABLE TRAY

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

1. CPI Chatsworth, Contractor Provided

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: as indicated on Drawings.
3. Straight Section Lengths: 10 feet (3.0 m) except where shorter lengths are required to facilitate tray assembly.
4. Rung Spacing: 9 inches (225 mm)o.c.
5. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
6. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
7. No portion of the rungs shall protrude below the bottom plane of side rails.
8. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
9. Class Designation: Comply with NEMA VE 1, Class 5A, Class 8A
10. Splicing Assemblies: Bolted type using serrated flange locknuts.
11. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:
   a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
   b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
   d. Finish: Powder-coat enamel paint.
      1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
      2) Hardware: Chromium-zinc plated, ASTM F 1136 or Stainless steel, Type 316, ASTM F 593 and ASTM F 594. CPI or owner and consultant approved equal
2. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
3. Rung Spacing: 12 inches, (300 mm), no greater than 12”, o.c.
4. Radius-Fitting Rung Spacing: 9 inches, (225 mm), at center of tray's width.
5. Minimum Cable-Bearing Surface for Rungs: 7/8-inch, (22-mm), width with radius edges.

6. No portion of the rungs shall protrude below the bottom plane of side rails.
7. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb, (90-kg), concentrated load, when tested according to NEMA VE 1.
8. Load capacity: 132 lb/ft with support every 5', (200 kg/m with support every 1.5 m). Straight Section Lengths: 10 feet, (3 m), 12 feet, (3.6 m), except where shorter lengths are required to facilitate tray assembly.
9. Fitting Minimum Radius: 24 inches, (600 mm), 36 inches (900 mm), 48 inches, (1200 mm), dependent on cable tray sized used
10. Class Designation: Comply with NEMA VE 1, Class 12B, Class 12C, Class 20B, and Class 20C..
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316 Steel, zinc plated according to ASTM B 633.
13. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

## 2.4 WIRE-BASKET CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. CPI Chatsworth, Contractor Provided

B. Description:
   1. Configuration: Galvanized- steel wire mesh, complying with NEMA VE 1.
   2. Width: 12 inches (300 mm) unless otherwise indicated on Drawings.
   3. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
   4. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
   5. Class Designation: Comply with NEMA VE 1, Class 8A.
   6. Splicing Assemblies: Bolted type using serrated flange locknuts.
   7. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
   1. Steel:
      a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33
      b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
      c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.

d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.

1) Hardware: Galvanized, ASTM B 633 or Chromium-zinc plated, ASTM F 1136 or Stainless steel, Type 316.

## 2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

## 2.6 WARNING SIGNS

A. Lettering: 1-1/2-inch, (40-mm-), high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

## 2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

# PART 3 - EXECUTION

## 3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, and bonding.

C. Fasten cable tray supports to building structure and install seismic restraints.

D. Design fasteners and supports to carry cable tray, the cables and a concentrated load of 200 lb., (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 260548, "Vibration and Seismic Controls for Electrical Systems."

E. Support wire-basket cable trays with, trapeze hangers. Center support will not be accepted.

F. Support: trapeze hangers for wire-basket trays with 3/8-inch, (10-mm-), diameter rods.

G. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

H. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1, NEMA VE 2. Space connectors and set gaps according to applicable standard.

I. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

J. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

K. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

L. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

M. Install warning signs in visible locations on or near cable trays after cable tray installation.

## 3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

## 3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with Velcro; tie wraps shall not be used. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

C. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 60 inches (1524 mm).

D. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

E. In existing construction, remove inactive or dead cables from cable trays.

## 3.4 CONNECTIONS

A. Connect raceways to cable trays according to requirements in NEMA VE 2.

## 3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

## 3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.

3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

**END OF SECTION**

# SECTION 27 0544 – SLEEVES & SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS & CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0553 Identification for Communication Systems.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

### 1.3 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Fire stopping" for penetration fire stopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

## 1.4 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. 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.

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

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

## 1.5 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.

2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## 1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

## 1.8 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## 1.9 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, field inspector and company. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, installation supervisor, and Principal Skilled Technicians: As a minimum be required to have no less than (5) five years' experience in like work.
2. The Company/Contractor proposing shall provide historical data confirming the company has a minimum of (5) five years applicable experience.

B. The Company/Contractor shall have a minimum of (3) three projects of similar size and type within the last (2) years. References for all submitted projects are required to assist with the evaluation.

C. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: Documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

D. Source quality-control reports.

E. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch, (0.6-mm), minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches, (1270 mm) and with no side larger than 16 inches, (400 mm), thickness shall be 0.052 inch, (1.3 mm).
   b. For sleeve cross-section rectangle perimeter 50 inches, (1270 mm), or more and one or more sides larger than 16 inches, (400 mm), thickness shall be 0.138 inch (3.5 mm).

### 2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.
2. Sealing Elements: EPDM, Nitrile, (Buna N), rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel, Plastic, Stainless steel.

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

## 2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, water stop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber water stop collar with center opening to match piping OD.

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

a. Presealed Systems.

## 2.4 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall be used in accordance with manufacturer’s guidelines.

3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

## 2.5 FIRESTOP

A. Furnish and install re-enterable UL listed fire rated assemblies through fire rated partitions, walls and floors. Installed per manufacturer and UL system assembly requirements.

B. Acceptable Manufacturers

1. STI (Specified Technologies Inc.) or similar

C. Fire Rated Cable Pathways: STI EZ-PATH modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:

1. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway.

a. Do not exceed manufacturer’s fill ratio recommendations.

D. Where a mechanical UL listed device/assembly is not practical to install, openings within floors and walls to accommodate communications cabling shall be provided with a re-enterable product that do not dry or cure.

E. Cable Trays are not permitted to penetrate rated wall assemblies.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch (6.4-mm), annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed, or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel, cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

## 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.3 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

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

## 3.4 SPECIAL CONDITIONS

A. All first floor Animal Holding, Behavior and Anterooms device boxes shall be cast type. Where device boxes and conduits are recessed mounted, the box to the adjacent wall, ceiling of floor surface shall be sealed. All wiring shall be provided in either threaded RGS, IMC (when recessed), or electrical metallic tubing when recessed and with compression fittings. Once wiring is installed, the wiring shall be surrounded by a one inch barrier of silicone caulking around the conductors within the device box hub. Gasketed device cover plates shall be used, with an additional continuous bead of silicone caulk between the device plate and the adjacent wall, ceiling, or floor surface. Where device boxes and conduits are surface mounted, and where the device box meets the wall, ceiling, or floor surface, a continuous bead of silicon caulk shall be provided. No recessed conduits are then required to be threaded RGS on minimum ¾: standoffs, or if also surface mounted, both sides of the conduit shall be sealed to adjacent surfaces with silicone caulk. This prevents vermin harborage in and transmission through the electrical systems.

**END OF SECTION**

# SECTION 27 0553 – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

## PART 1 - GENERAL

### 1.1 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the labeling of the telecommunications infrastructure as described on the Drawings and/or required by these specifications.

B. It is the intent to create a Class 3 system of administration as per ANSI/TIA/EIA 606-A Standards. As such, all elements must be labeled with unique identifiers as described in the following sections.

C. This section includes minimum requirements for the following:

1. Labeling Communications Cabling
2. Labeling Closet Hardware
3. Labeling Work Stations

### 1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 1100 Communications Equipment Room Fittings.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

## PART 2 - PRODUCTS

### 2.1 LABELS

A. The size, color and contrast of all labels should be selected to ensure that the identifiers are easily read.

B. All labels are to be mechanically printed, no hand printed labels allowed for any component.

C. Labels should be visible during the installation of and normal maintenance of the infrastructure. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat or ultraviolet light) and should have a design life equal to or greater than that of the labeled component.

D. Provide vinyl substrate with a white printing area and black print. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.

E. Labels shall be flexible vinyl or other substrates to apply easy and flex as cables are bent.

F. Labels shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing.

## PART 3 - EXECUTION

### 3.1 LABELING INSTALLATION

A. Horizontal Copper Cable Labeling:

1. All horizontal cables shall be labeled with self-laminating marking tape, Brady ID-Pro labeler, Panduit LS7 labeler, or equivalent labeling system. Identification shall be as follows:
2. At the TR end, the cables shall be labeled with the location of where the other end of the cable is terminated including room number, TO number, and jack position. Place label on a visible part of cable within 12” of termination point for ease of identification after termination.
    a. Example: A cable going to room 114, first TO, first jack position would be labeled as: 114-1A1. A cable in the second TO, third jack position would be 114-2A3.
3. At the TO end, the cables shall be labeled 4” from termination with the following: TR – Rack.Patch Panel.Port. This shall be visible by removing outlet cover plate.
    a. Example: TR Room 114, rack 1, patch panel 1, port 03 would be: 114 – 1.1.03
    b. For voice cabling in older building with separate voice closets and no patch panels, include the TR and as much information as practical such as column, row, block number, and port number or pairs.
        1) Example: TR room 105, on a 110 block in the first column, third row down, port 4 would be: 105-1.3.04

2) Example: TR room 105, no discernable pattern of columns or rows or ports, and/or mixed environment of 110 and 66 blocks, the label could be: 105 - E wall – 51/54.

B. Telecommunications Outlet (TO) Labeling Scheme:

1. TO's are labeled alphanumerically in a clockwise rotation around the room. Typically, the first TO located to the left of the main entrance of the room is labeled 1A, followed by 2A, 3A, etc. Where two entrances are present, designate one as the main entrance and label accordingly.

   a. The intent is to have unique identification for each TO. The starting point and nomenclature of the TO's are irrelevant to the location inside the room.

2. Floor box TO's are to be prefaced with "FB" to read FB1A, FB2A, etc.

3. Wireless Access Point TO's in ceilings are to be prefaced with "W" to read W1A, W2A, etc.

4. On subsequent TO installations, the TO will be labeled alphanumerically depending on where the new TO is. If the new TO is between 1A and 2A, the new TO would be labeled as 1B. If another one is later added between 1B and 2A, it would be labeled 1C. If it is after the last TO in the room, 3A, it would be labeled 4A.

5. Seek clarification from Design Team for any labeling issues that arise.

C. Faceplate Labels:

1. Faceplates will be labeled using the plastic insert to cover a printed identification tag. Each of the 2 labels in a faceplate are meant to have 2 lines for a total of 4 individual lines per faceplate.

2. The TO label will vary slightly depending on whether a unified cabling platform is used where all cables go to one TR, or separate voice and data closets are used.

3. See addendum 2 for an example spreadsheet in MS Excel with dimensions for the labels.

   a. Line 1 contains the preface "D" for Data, the specific TR, rack, patch panel, and the range of ports used for termination. In case of separate voice and data closets, only the data information is conveyed here.

      1) Example: For cables going to TR Room 114, rack 1, patch panel 1, ports 3-5, line 1 would read: D.114.1.1.03/05.

   b. Line 2 also contains information regarding where cables are terminated in the closet, but is used for subsequent cable installations to that specific TO.

      1) Example: Another 3 cables were added to the same TO at a later date. For cables that go to TR Room 114, rack 3, patch panel 3, ports 22,23, and 30, line 2 would read: D.114.3.3.22/23.30.

   c. Line 3 is only used if separate voice and data closets are being used. Line 3 contains the preface "V" for Voice, the TR, and the TO number and jack position.

      1) Example: For 2 cables going to voice closet 117 in the 3rd and 4th position of TO 2A, the label would be: V.117.2A3/4.

d. Line 4 is the unique identifier for the TO. It contains the Building number, the room the TO is located in, and the alphanumeric designation of the TO as per section 4.01.B.

1) Example: A TO in room building 255, room 114, designated as 2A would be: 255-114-2A.

D. Horizontal 110 and 66 Block Labeling for voice:

1. For 110 blocks, if the cables are for room terminations, label the appropriate corresponding space for the port with the room number, TO, and jack position.

a. Example: A cable going to room 114, first TO, first jack position would be labeled as: 114-1A1. A cable in the second TO, third jack position would be 114-2A3.

2. For 66 type blocks, if the cables are for room terminations, tag the cable with the room number, TO, and jack position with a loose paper tag that is easily accessible and readable.

a. Example: A cable in room 114, first TO, first jack position would be labeled as: 114-1A1. A cable in the second TO, third jack position would be 114-2A3.

3. If the 110 block is for the tie cable between the voice patch panel in the rack and the wallboard, label the space corresponding to the port with the rack, patch panel and port information as per section 4.01.E.2. For tie cables between the rack and wallboard a 110 block should always be used.

a. Example: Rack 1, patch panel 1, port 03 would be: 1.1.03

E. Patch Panel Labeling:

1. For station cabling going to a TO, label each port on the patch panel with the room number, TO, and jack position.

a. Example: A cable in room 114, first TO, first jack position would be labeled as: 114-1A1. A cable in the second TO, third jack position would be 114-2A3.

b. Example: A cable going to a floor box TO labeled FB1A in room 114 in the second jack position would be labeled as: 114-FB1A2

2. For voice patch panels connected to a 110 block within the TR, label each port on the voice patch panel with the corresponding 110 block source information as per section 4.01.D.3.

a. Example: A 110 block in the first column, third row down, port 4 would be: 1.3.04

F. Vertical/Riser/Intrabuilding Copper Cable Labeling:

1. All riser cables shall be labeled with self-laminating marking tape, Brady ID-Pro labeler, Panduit LS7 labeler, or equivalent labeling system.

2. At the TR, the copper riser cables shall be labeled with from/to, cable type (C for copper), cable number, and count information on both ends. Place label on a visible part of cable close to wiring block for ease of identification after termination.

a. Example: From BDF B065 to IDF 114, first of 2, 50 pair cables would be: B065 – 114 – C01, 1-50. The second 50 pair cable between the rooms would be B065 – 114 – C02, 51-100.

3. Label cabling every 50’ along the length of the cable in open trays, and on each side of wall penetrations.

G. Vertical/Riser/Intrabuilding Fiber Cable Labeling:

1. All riser cables shall be labeled with self-laminating marking tape, Brady ID-Pro labeler, Panduit LS7 labeler, or equivalent labeling system. Identification shall be as follows:

2. At the TR, the fiber riser cables shall be labeled with from/to, cable type (F for Fiber), and cable number on both ends. Place label on a visible part of cable close to wiring block for ease of identification after termination.

   a. Example: From BDF B065 to IDF 114, first cable, would be: B065– 114 – F01. The second fiber bundle between the rooms would be B065 – 114 – F02.

3. Label cabling every 50’ along the length of the cable in open trays, and on each side of wall penetrations.

H. Vertical/Riser/Intrabuilding 110-Block Labeling

1. At the BDF and IDF, voice riser cables are terminated on their respective 110 blocks. Label only first and last pairs on each row of 110 blocks with the matching pair count information.

2. Place the entire cable label in the center of the 110 block label as per section 4.01.F: B065 – 114 – C01, 1-50

I. Coax trunk Labeling (CATV)

1. CATV coaxial trunk cables shall be labeled at each termination point with the information indicating the location of the next termination point of the cable, such as an amplifier, DCT, splitter, or tap.

J. Vertical/Riser/Intrabuilding and Campus Fiber FDU labels

1. Labels shall indicate type of fiber (single mode or multi-mode 50 or 62.5 micron), from/to information, pair count, loss for each strand, and length of cable.

K. Interbuilding/Campus/Backbone Copper and Fiber Cable Labeling:

1. All interbuilding cables shall be labeled permanently with from/to information, cable type and size, installation date, and installing contractor at each end, manhole, and pullbox the cable passes through.

   a. Example: From Building 256 to 203, a 200 pair copper cable, installed by RMV Enterprises on September 22, 2006 would be: 256/203 – 200 Pair Copper – 9/22/06 – RMV Enterprises.

**END OF SECTION**

# SECTION 27 1100 – COMMUNICATIONS EQUIPMENT ROOM FITTINGS

## 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 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

### 1.3 SUMMARY

A. Section Includes:

1. Backboards.
2. Grounding.

### 1.4 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. RCDD: Registered communications distribution designer.

D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

E. TGB: Telecommunications grounding bus bar.

F. TMGB: Telecommunications main grounding bus bar.

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. 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.

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

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

## 1.8 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.

2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## PART 2 - PRODUCTS

### 2.1 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches, (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Section 06 1000 "Rough Carpentry." Use fire rated plywood. Paint all sides with two coats of fire retardant paint. Do not paint over plywood rating stamp.

### 2.2 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless, compression exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide, (6 mm thick by 100 mm wide), with 9/32-inch, (7.14-mm), holes spaced 1-1/8 inches, (28 mm), apart.

3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with TIA/EIA-607-B.

### 2.3 LABELING

A. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with site specific labeling requirements as defined by the owner

## PART 3 - EXECUTION

### 3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

## 3.2 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 0544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

## 3.3 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.

1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Backboards:

1. Install from 4 inches (150 mm) to 8 feet, 4 inches (2588 mm) above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-C.

## 3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA/EIA-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

## 3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for all Class 3 and Class 4 level of administration, including optional identification requirements of this standard.

D. Labels shall be preprinted or computer-printed type.

## 3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-C, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

**END OF SECTION**

# SECTION 27 1116 – COMMUNICATION RACKS, FRAMES, AND ENCLOSURES

## 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 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

### 1.3 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. Power strips.
3. Grounding.
4. Labeling.
5. Patch Panels

## 1.4 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TGB: Telecommunications grounding bus bar.

G. TMGB: Telecommunications main grounding bus bar.

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum

number of components capable of being mounted in each rack type. Identify components on which certification is based.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. 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.

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

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

F. Grounding: Comply with TIA-607-B.

## 1.8 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.
2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. UL listed.

B. RoHS compliant.

C. Compliant with requirements of the Payment Card Industry Data Security Standard.

### 2.2 19-INCH EQUIPMENT RACKS

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

1. CPI Chatsworth, Contractor Provided

B. Refer to Appendix A – Approved Parts List of NMSU Division 27 Communication Infrastructure Standards, 2020 for Approved manufacture model #s.

C. Description: Two- and four- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch (482.6-mm) equipment mounting with an opening of 17.72-inches (450-mm) between rails.

D. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Finish: Manufacturer's standard, baked-polyester powder coat.

E. Floor-Mounted Racks:

1. Two-Post Load Rating: 200 lb (91 kg).
2. Four-Post Load Rating: 1000 lb (454 kg).
3. Number of Rack Units per Rack: 45
4. Threads: Universal square.
5. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
6. Base shall have a minimum of four mounting holes for permanent attachment to floor.
7. Top shall have provisions for attaching to cable tray or ceiling.
8. Self-leveling.

F. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

## 2.3 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Coordinate with NMSU ICT for Power Strip configuration.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
7. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
8. Cord connected with 15-foot (4.5-m) line cord.
9. Rocker-type on-off switch, illuminated when in on position.
10. Peak Single-Impulse Surge Current Rating: 13 kA per phase.
11. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

## 2.4 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

1. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.
2. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
3. Rack-Mounted Horizontal TGB: Designed for mounting in 19-inch (482.6) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

## 2.5 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Refer to NMSU Division 27 Standards and NMSU ICT Dept for exact requirements.

1. Coordinate with NMSU ICT prior to commencing work.

## 2.6 PATCH PANELS

A. Manufacturers:

1. Commscope Uniprise (SL Series)
   a. 48 Port Angled – CPPA-UDDM-SL-2U-48 760-237-043
   b. 48 Port Flat – CPP-UDDM-SL-2U-48 760-237-04
2. Substitutions: Only by prior approval from NMSU ICT.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.

1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

## 3.2 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches (50 mm) of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

## 3.3 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 4 level of administration.

D. Labels shall be machine printed. Type shall be 1/8 inch (3 mm) in height.

**END OF SECTION**

# SECTION 27 1300 – COMMUNICATIONS BACKBONE CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

I. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

### 1.3 SUMMARY

A. Section Includes:

1. Pathways.
2. OSP Copper cabling
3. UTP cable – contractor provided
4. Fiber Optic Cable – Intra-building Fiber – 24 count SM MIC plenum. Corning Part # 024E88-33131-29. Inter-building Fiber - 48 count SM LT Altos. Corning Part # 048EU4-T4101D20
5. Cabling identification products.

## 1.4 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

## 1.5 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

## 1.6 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-C.1, when tested according to test procedures of this standard.

## 1.7 ACTION SUBMITTALS

A. Product Data: Submit for each type of product indicated.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical and mechanical elements. Include the following:
    a. Vertical and horizontal offsets and transitions.

b. Clearances for access above and to side of cable trays.

c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

## 1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector. (See 1.10-A 1-3) Submit qualifications.

B. Source quality-control reports.

C. Field quality-control reports.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

## 1.9 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

## 1.10 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD and a full time staff member to supervise all on-site testing.

B. 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.

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

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-C.

E. Grounding: Comply with TIA/EIA-607-B.

## 1.11 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have 5 (five) years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and 3 (three) years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a 3 (three) year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of 5 years' experience in like work.

2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## 1.12 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.

2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices and connector, including the loss value of each. Retain test data and include the record in maintenance data.

3. Test each pair of UTP cable for open and short circuits.

## 1.13 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## 1.14 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

## PART 2 - PRODUCTS

## 2.1 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches, (19 by 1220 by 2440 mm). Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels. Paint all sides with two, (2), coats of fire retardant paint. Do not paint over plywood rating stamp.

## 2.2 OSP COPPER

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

1. Commscope Contractor provided.

B. Description: 100-ohm, 25-pair, formed into 25-pair binder groups covered with a thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA-568-C.1 for performance specifications.
3. Comply with TIA-568, Category 3.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
    b. Communications, Riser Rated: Type CMR, complying with UL 1666.

## 2.3 UTP CABLE – INTERIOR APPLICATIONS

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

1. Commscope

B. Description: 100-ohm, 25-pair UTP, formed into 25-pair binder groups covered with a thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA-568-C.1 for performance specifications.
3. Comply with TIA-568, Category 3.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

b. Communications, Riser Rated: Type CMR, complying with UL 1666.

## 2.4 UTP CABLE HARDWARE

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

1. Commscope

B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

## 2.5 OPTICAL FIBER CABLE

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

1. Corning Cable Systems.

B. Description: OS2 single mode nonconductive, CMP, (indoor/outdoor, plenum rated, dependent on environmental conditions), tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-C.3 for performance specifications.
3. Comply with TIA/EIA-492CAAB for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   a. Maximum Attenuation (dB) / km 3.5 @ 850nm / 1.5 @ 1300nm, OM 4. 0.65db/km @1310nm, 0.65db/km @ 1383nm, 0.50db/km @1550nm, OS 2
   b. Minimum Modal Bandwidth OFL (MHz x km) 2000 @ 850nm / 500 @ 1300nm, OM 4. 1310, 1383, 1550 OS 2

C. Jacket:

1. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-D.
2. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

## 2.6 OPTICAL FIBER CABLE HARDWARE

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

1. Corning Cable Systems.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA-604-12. Comply with TIA-568-C.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

## 2.7 GROUNDING

A. Comply with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA/EIA-607-B.

## 2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## 2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-C.1.

C. Factory test UTP cables according to TIA/EIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-B and TIA/EIA-568-C.3.

E. Cable will be considered defective if it does not pass tests and inspections. Cable that does not pass test and inspections shall be replaced.

F. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Contractor is to install all required cabling, terminate, and test cabling.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

### 3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Contractor is to install all required cabling, terminate, and test cabling.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
8. In the communications equipment room, install a 10-foot, (3-m-), long service loop on each end of cable.

9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-C.2.
2. Do not untwist UTP cables more than 1/4 inch, (6.35mm), from the point of termination to maintain cable geometry.
3. Contractor is to install all required cabling, terminate, and test cabling.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-C.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wire way or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches, (1524 mm), apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-C recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches, (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches, (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches, (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches, (64 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches, (150 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches, (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches, (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches, (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches, (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches, (127 mm).

## 3.3 FIRESTOPPING

A. Comply with requirements in Section 07 8413 "Penetration Fire stopping."

B. Comply with TIA/EIA-569-C; Annex A, "Fire stopping."

C. Comply with BICSI TDMM, "Fire stopping Systems" Article.

## 3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA/EIA-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch, (50-mm), clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

## 3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."
   1. Administration Class: 3, 4.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 09 9123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for Class 4 level of administration including optional identification requirements of this standard.

D. Comply with requirements in Section 27 1500 "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches, (100 mm), of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet, (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with a name and number of a particular device as shown.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-B, for the following:

1. Cables; use flexible vinyl or polyester that flexes as cables are bent.

## 3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration

4. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-B, Method B, One Reference Jumper.

2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-C.1.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

## 3.7 SYSTEM WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide site plans showing locations of all telecommunication routes. See Item 3.06.

D. Contractor shall submit final paperwork for warranty to manufacturer and a copy to the Owner one week prior to the substantial completion date.

E. Contractor must be a certified as required by the owner and approved solution supplier such as Mohawk, Berk-Tek, Ortronics, and Siemens.

F. Contractor must offer a minimum 20-year extended manufacturer's warranty for the premises fiber cabling solution comprised of approved manufacturer products and must follow all warranty registration procedures set forth by the manufacturer, including submitting all required documentation to the manufacturer for warranty certification.

G. All installed equipment must conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of 20 years (minimum) from that date. The contractor shall agree to repair, adjust, and/or replace, as determined by the owner and to replace defective equipment, materials, or other parts of the system at the contractor's sole cost. Owner will incur no costs for service or replacement of parts during the warranty period of 20 years. All third party warranties shall be passed through from the contractor to the owner.

H. Contractor shall warrant that the system will function as specified in the approved manufacturer's Technical Description Guide.

I. Contractor shall warrant that the system shall accommodate the specifications in all appropriate sections of this Request for Proposal and all applicable sections of the owners Specifications.

**END OF SECTION**

# SECTION 27 1500 – COMMUNICATIONS HORIZONTAL CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

I. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

J. Division 27, Section 27 1543 Communications Faceplates and Connectors.

### 1.3 SUMMARY

A. Section Includes:

1. UTP cabling, (contractor provided)
2. Cabling system identification products.
3. Cable management system.

B. Related Requirements:

1. Section 27 1300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

2. Section 28 1300 "Access Control" for cabling associated with system panels and devices.
3. Section 28 1600 “Intrusion Detection” for cabling associated with system panels and devices.
4. Section 28 2300 “Video Surveillance” for cabling associated with system panels and devices.
5. Section 28 3200 “Rescue Communication Systems” for cabling associated with system panels and devices.

## 1.4 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

G. RCDD: Registered Communications Distribution Designer.

H. UTP: Unshielded twisted pair.

## 1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

## 1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For coaxial cable, include the following installation data for each type used:
    a. Nominal OD.
    b. Minimum bending radius.
    c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:
   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.
5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

## 1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

## 1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

## 1.9 MAINTENANCE MATERIAL SUBMITTALS

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

1. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.
3. Device Plates: One of each type.
4. Multiuser Telecommunications Outlet Assemblies: One of each type.

## 1.10 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff. (submit qualifications)

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, Cabling Administration Drawings and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. 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.

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

E. Telecommunications Pathways and Spaces: Comply with TIA-569-C.

F. Grounding: Comply with TIA-607-B.

## 1.11 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have (5) five years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and (3) three years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a (3) three year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

B. The contractor shall have on staff a BICSI Certified RCDD as a permanent employee. This staff member shall have been on staff for a minimum of (1) one year prior to the date of this projects release for bid.

C. The contractor shall have on staff at least (1) one BICSI Certified Technician and this staff member shall have been a full time employee for no less than (1) one year prior to the date of this projects release for bid. A BICSI Certified Technician shall be employed as the on-site Field Supervisor for this project.

D. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.

1. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of (5) five years' experience in like work.

2. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## 1.12 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.

2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.

3. Test each pair of UTP cable for open and short circuits.

# PART 2 - PRODUCTS

## 2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-C.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.

2. Contractor is to install all required cabling, terminate, and test cabling.

B. A work area is approximately 100 sq. ft., (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet, (90 m). This maximum allowable length does not include an allowance for the length of 16 feet, (4.9 m), to the workstation equipment or in the horizontal cross-connect.

## 2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-C.1 when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing 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.

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

D. Grounding: Comply with TIA/EIA-607-B.

## 2.3 UTP CABLE

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

1. Commscope

B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-C.1 for performance specifications.
3. Comply with TIA/EIA-568-C.2 Category Cable
   a. Consult Annex G for length de-rating guidance for installations in higher temperature.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
5. For Category 6A applications provide CS44P Category 6A cable.
   a. Comply with ANSI/TIA-568.2 D

## 2.4 UTP CABLE HARDWARE

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

1. Commscope /

B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

## 2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA-568-C.1.

B. Workstation Outlets: Two or Four-port-connector assemblies (as shown in drawings) mounted in single or multigang faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."

2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."

3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

C. Animal Research Spaces

1. Device boxes in animal research spaces require cast boxes with external hub and gasketed device cover plate and specific silicone caulking.

## 2.6 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

## 2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-B and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 26 0553 "Identification for Electrical Systems."

## 2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-C.1.

C. Factory test UTP cables according to TIA/EIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA/EIA-568-C.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

### 3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Install “wet” rated cable when the voice and data cabling conduit pathway is in the slab or underground. Transition “wet” rated cable to plenum if pathway extends into a plenum space without conduit. Wet rated cable shall not be installed in the open plenum ceiling space.
3. Comply with requirements in Section 270528 "Pathways for Communications Systems."
4. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
5. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

### 3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Contractor is to install all required cabling, terminate, and test cabling.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
8. In the communications equipment room, install a 10-foot, (3-m), long service loop on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-C.2.
2. Do not untwist UTP cables more than 1/4 inch (6.35 mm) from the point of termination to maintain cable geometry.
3. Contractor is to install all required cabling, terminate, and test cabling.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-C.3.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches, (200 mm), above ceilings by cable supports not more than 60 inches, (1524 mm), apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-C for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

H. Protect cabling during installation:
   1. Protect voice and data cabling cables from any liquid, paints, solvents, debris, or other contaminates, per the manufacturers installation guidelines. Cables shall be replaced if damaged.

## 3.4 FIRESTOPPING

A. Comply with requirements in Section 07 8413 "Penetration Firestopping."

B. Comply with TIA-569-C; Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

## 3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding and Electrical Protection" Chapter.

B. Comply with TIA/EIA-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch, (50-mm), clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

## 3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-B. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

1. Administration Class: 3, 4, TIA/EIA-606-B.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Section 09 9123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-B for Class 4 level of administration, including optional identification requirements of this standard.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-B. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches, (100 mm), of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet, (4.5 m).
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device, shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-B.
1. Cables use flexible vinyl or polyester that flex as cables are bent.

## 3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration

4. Optical Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

   b. Link End-to-End Attenuation Tests:

      1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-B, Method B, One Reference Jumper.

      2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-C.1.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

## 3.8 SYSTEM WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide site plans showing locations of all telecommunication routes. See Item 3.06.

D. Contractor shall submit final paperwork for warranty to manufacturer and a copy to the Owner one week prior to the substantial completion date.

E. Contractor must be a certified as required by the owner and approved solution supplier such as Mohawk, Berk-Tek, Ortronics, and Siemens.

F. Contractor must offer a minimum 20-year extended manufacturer’s warranty for the premises fiber cabling solution comprised of approved manufacturer products and must follow all warranty registration procedures set forth by the manufacturer, including submitting all required documentation to the manufacturer for warranty certification.

G. All installed equipment must conform to the manufacturer's official published specifications. The warranty shall begin at the system acceptance date and remain in effect for a period of 20 years (minimum) from that date. The contractor shall agree to repair, adjust, and/or replace, as determined by the owner and to replace defective equipment, materials, or other parts of the system at the contractor's sole cost. Owner will incur no costs for service or replacement of parts during the warranty period of 20 years. All third party warranties shall be passed through from the contractor to the owner.

H. Contractor shall warrant that the system will function as specified in the approved manufacturer's Technical Description Guide.

I. Contractor shall warrant that the system shall accommodate the specifications in all appropriate sections of this Request for Proposal and all applicable sections of the owners Specifications.

**END OF SECTION**

# SECTION 27 1543 – COMMUNICATIONS FACEPLATED AND CONNECTORS

## PART 1 - GENERAL

### 1.1 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the labeling of the telecommunications infrastructure as described on the Drawings and/or required by these specifications.

B. This section includes minimum requirements for the following:

1. Faceplates
2. Connectors

### 1.2 RELATED SECTIONS

A. New Mexico State University ICT-TNS Division 27 Communications Infrastructure Standards (2020). (Provided by NMSU ICT upon request) Provides additional requirements for Division 27 systems that may not be covered in the below sections.

B. Division 27, Section 27 0526 – Grounding and Bonding for Communications Systems

C. Division 27, Section 27 0528 Pathways for Communication Systems.

D. Division 27, Section 27 0536 Cable Trays for Communications Systems.

E. Division 27, Section 27 0544 Sleeves and Sleeve Seals for Communications Pathways and Cabling.

F. Division 27, Section 27 0553 Identification for Communication Systems.

G. Division 27, Section 27 1100 Communications Equipment Room Fittings.

H. Division 27, Section 27 1116 Communications Racks, Frames and Enclosures

I. Division 27, Section 27 1300 Communications Optical Fiber Backbone Cabling.

J. Division 27, Section 27 1500 Communications Copper Horizontal Cabling.

## PART 2 - PRODUCTS

### 2.1 FACEPLATES

A. Standard faceplates are CommScope Uniprise SL Series faceplates and inserts or 110Connect single and double gang faceplates –either type is acceptable – standard faceplate color is almond, standard insert color is orange. Communications outlets are typically within 3 feet of an electrical outlet and installed at the same height, unless otherwise specified. Communications outlets should be placed so that the work area or workstation cable does not exceed 5 meters (16 ft) in length. This length is figured into the total horizontal cabling length and must not be exceeded. All labels are to be mechanically printed, no hand printed labels allowed for any component.

### 2.2 CONNECTORS

A. All modular jacks shall be un-keyed, unshielded, 4-pair, RJ-45, and shall fit in a .790" X .582" opening. Modular jacks shall terminate using 110-style pc board connectors, color-coded for both T568A and T568B wiring. Each modular jack shall be wired to T568B. The 110-style insulation displacement connectors shall be capable of terminating 22-24 AWG solid or 24 AWG stranded conductors. The insulation displacement contacts shall be paired with additional space between pairs to improve crosstalk performance. Modular jacks shall utilize a secondary PC board separate from the signal path for crosstalk compensation. Each modular jack shall meet the Category 6 or 6A performance standards and the requirements. The jack color will be orange unless otherwise specified.

B. Modular jacks shall be compatible with the CommScope Uniprise SL Series Modular Jack Termination Tool part number 1725150-1. Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination. Modular jacks shall be UL Listed under file number E81956. See approved parts list at end of document.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. This Section describes the installation locations for the products and materials, as well as methods and NMSU IT Standards associated with the Telecommunications Installation portions of the Project. These Specifications, along with the drawings and other NMSU IT supplied specifications shall be followed during the course of the installation.

B. The contractor is required to be currently listed as an approved manufacturer registered Certified Installer and provide personnel for telecommunications installations who are certified and meet warranty requirements established by the manufacturer.

C. The Contractor is instructed to coordinate his efforts with the other tradesmen who may be working within the same vicinity to avoid conflict and lost time.

D. The Contractor is required to supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.

E. The Contractor shall verify space requirements and locations with NMSU IT prior to starting cable installations and terminations.

F. All terminations are to use TIA T568B wiring standards.

G. Terminate according to the manufacturer's instructions.

## 3.2 TERMINATIONS

A. Twisted pair cable.

1. All twisted pair cable shall be terminated as described by the manufacture with the proper tools.

B. Coax Cable

1. All Coax cable shall be terminated using connectors matching cable type and application, tool assembly matching connector type for crimp or compression type connectors and follow Manufacturer procedures for termination.

C. Optical Fiber Cable

1. Optical Fiber terminated at the desk top will be with LC connectors following manufacture procedure. Optical fiber terminated in TR/ER's shall be fusion type LC connectors or fusion spliced pigtails using LC connectors when specified, on all new projects, existing projects where optical fiber is being added confirm in writing connector type with NMSU IT.

## 3.3 EQUIPMENT INSTALLATION AND CABLE TERMINATIONS

A. All equipment shall be installed in a neat and workmanlike manner, arranged for convenient operation, testing and future maintenance.

B. All telecommunications cables, faceplates, and connectors shall be installed and terminated by manufacturer certified technicians experienced in the installation and termination of telecommunications items listed herein.

C. The contractor shall provide manufacturer certified technicians and installers per all the requirements of the current on call contractor RFP.

## 3.4 SPECIAL CONDITIONS

A. All Animal Holding, Behavior and Anterooms device boxes shall be cast type. Where device boxes and conduits are recessed mounted, the box to the adjacent wall, ceiling of floor surface shall be sealed. All wiring shall be provided in either threaded RGS, IMC (when recessed), or electrical metallic tubing when recessed and with compression fittings. Once wiring is installed, the wiring shall be surrounded by a one inch barrier of silicone caulking around the conductors

within the device box hub. Gasketed device cover plates shall be used, with an additional continuous bead of silicone caulk between the device plate and the adjacent wall, ceiling, or floor surface. Where device boxes and conduits are surface mounted, and where the device box meets the wall, ceiling, or floor surface, a continuous bead of silicon caulk shall be provided. Nonrecessed conduits are then required to be threaded RGS on minimum ¾: standoffs, or if also surface mounted, both sides of the conduit shall be sealed to adjacent surfaces with silicone caulk. This prevents vermin harborage in and transmission through the electrical systems.

## 3.5 AS-BUILT INFORMATION

A. Contractor shall provide 1 set of preliminary as-built information to NMSU IT along with all test result information 2 weeks prior to occupancy or substantial complication. Partial as-builts shall be submitted as cabling is completed. A final as-built shall be submitted with all corrections made a maximum of 30 days after cabling installation is complete.

B. As-built information shall be in electronic PDF format. Indicate location of all TOs, pathways, distribution cable trays, junction boxes, and all additions and deletions pertaining to telecommunications. Include correct TO labeling next to all telecom symbols.

C. If construction drawings are not utilized, contractor shall provide all telecommunications location information on an accurate and scaled floor plan.

## 3.6 WARRANTY

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.

B. Contractor shall submit cable records to reflect all moves, adds, and changes.

C. Contractor shall provide floor plans showing locations of all telecommunication outlets and spaces.

D. Contractor shall perform these requirements for category 6 and 6A permanent link configurations and submit to the hardware manufacturer such paperwork and test results as necessary to obtain a minimum 20-year system performance guarantee to NMSU as defined by the cable and hardware manufacturers. The 20-year minimum system warranty shall be provided to NMSU IT.

**END OF SECTION**

# SECTION 27 4100 – COMMON WORK RESULTS FOR AUDIO VIDEO SYSTEMS

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section includes NMSU New Mexico Department of Agriculture Office Building Audio-Video Systems.

B. The term “provide” used throughout this specification and drawings shall mean “furnish, install, test, and certify”.

C. Within two weeks after award of contract, the Contractor shall arrange a “CA kickoff” meeting and/or conference call with the General Contractor, Construction Manager, Architect, Consultant, and Owner (when applicable) to discuss general project expectations.

D. Coordinate project schedule, installation schedule, phasing and any other requirements deemed necessary with Construction Manager and all necessary trades to ensure successful completion of work.

E. Phasing, temporary distribution/equipment, cutover and implementation where applicable, shall be coordinated with the Construction Manager.

F. Extent of Audio-Video Systems infrastructure work is indicated by Division 26 “Electrical” sections, drawings and schedules and is hereby defined to include, but not by way of limitation, the provisions of:

1. Raceway systems including but not limited to conduits, cable trays, sleeves, surface raceways, pull-boxes, junction boxes, back-boxes, etc.
2. Power distribution within equipment racks including programable power sequencing of AC circuits.
3. All AV system related infrastructure shall be provided as part of the Base Building Project including but not limited to raceway, cable, cable terminals, and AV equipment rack room fit-out where applicable.

G. Extent of Audio Video Systems Infrastructure as indicated by Division 27 “Communications” and those associated specification sections that address Ethernet and IT requirements shall include but not be limited to:

1. Patch cords, jumper cables, and cross-connect cables to interconnect wiring terminals as well as electronic equipment.
2. Network connectivity: a channel is defined as the connection from one active device to another, including any patch cords and equipment cords and shall not exceed 100 meters total length.
3. Testing of all category type cable infrastructure and grounding systems as noted by specification, drawings, and applicable industry standards.

H. General requirements also include but are not limited to:

1. AV Head-end room hardware and component fit-out including cabinets, racks, cable tray, backboard, and raceways for terminating cable and installation of electronic equipment.
2. Grounding and bonding of all metallic hardware components back to the nearest grounding bus including, but not limited to equipment racks, cabinets, cable trays, ladder rack, metallic cable sheaths, wall mounted wiring terminals, conduits, sleeves, metallic ductwork, and frames.
3. All physical cable management hardware including, but not limited to: “J-hooks” in accessible ceiling areas where conduit has not been provided for, “D-rings” on backboards, vertical and horizontal managers on racks and cabinets, vertical and horizontal ladder-type or wire basket cable tray within AV head-end equipment rooms.
4. The use of Velcro type cable ties are required; the use of plastic zip ties shall not be permitted. No exceptions.
5. Fire stopping as required. Contractor shall provide fire stopping for all low-voltage openings (including empty low voltage raceway) once cable installation is complete. Confirm specific fire stopping scope requirements with Construction Manager.
6. Seismic bracing of all equipment racks, ladder-type or wire basket cable trays, ceiling recessed equipment such as loudspeakers, plenum boxes etcetera as required by code and by local governing jurisdiction.
7. Preparation and submission of product data, shop drawings, testing reports, as-built drawings, and cabling documentation as required in this specification.
8. Construction and Installation warranties.
9. Manufacturer components, channel and solutions warranties.
10. Installation and testing of all system and components shall be documented.
11. Onsite administrative and user training.

## 1.2 RELATED DOCUMENTS

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

B. Division 26 Electrical Sections pertaining to basic materials and installation methods, raceways, boxes, supports, grounding and bonding, and wiring.

C. Division 27 Telecommunication Sections pertaining to structured UTP/STP cabling, fiber optic cabling, low voltage coaxial signal distribution and installation methods.

D. Refer to the following section(s) for additional requirements:

1. Division 27 Section 27 41 00.10 AUDIO VIDEO SYSTEMS FOR TEST KITCHEN AND RECORDING SUITE
2. Division 27 Section 27 41 00.20 AUDIO VIDEO SYSTEMS FOR CONFERENCE ROOMS AND OTHER SPACES

E. Audio-Video Systems (AV) Construction Drawings for equipment locations, system layouts, one-line diagrams, and details.

## 1.3 REFERENCES

A. Audiovisual and Integrated Experience Association (AVIXA):

1. 10:2013 - Audiovisual Systems Performance Verification
2. A102.01:2022 - Audio Coverage Uniformity in Listener Areas
3. A103.01:2022 - Measurement and Classification of Spectral Balance
4. D401.01:2023 – Documentation Requirements for Audiovisual Systems
5. F501.01:2015 - Cable Labeling for Audiovisual Systems
6. F502.01:2018 - Rack Building for Audiovisual Systems
7. F502.02:201X - Rack Design for Audiovisual Systems
8. S601.01:2021 - Audiovisual Systems Energy Management
9. V201.01:2021 - Image System Contrast Ratio
10. V202.01:2016 - Display Image Size for 2D Content in Audiovisual Systems
11. J-STD-710 - Audio, Video and Control Architectural Drawing Symbols Standard
12. RP-C303.01:2018 - Recommended Practices for Security in Networked Audiovisual Systems
13. RP-38-17 - Lighting Performance for Small to Medium Sized Videoconferencing Rooms

B. Building Industry Consulting Service International (BISCI):

1. ANSI / BICSI 001 – Information and Communication Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities
2. ANSI / BICSI N1 – Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure
3. ANSI / BICSI N3 – Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure

C. Code of Federal Regulations (CFR):

1. 29 CFR 1910.268 – Occupation Safety and Health Standards (OSHA) – Telecommunications
2. 36 CFR 1191 – Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

D. Electronic Components Industry Association (ECIA):

1. ECIA EIA/ECA 310-E – Cabinets, Racks, Panels, and Associated Equipment

E. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code

2. NFPA 72 – National Fire Alarm and Signaling Code
3. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems

F. Telecommunications Industry Association (TIA):

1. TIA-568.0 – Generic Telecommunications Cabling for Customer Premises
2. TIA-568.1 – Commercial Building Telecommunications Infrastructure Standard
3. TIA-568.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standards
4. TIA-568.3 – Optical Fiber Cabling Components Standard
5. TIA-568.4 – Broadband Coaxial Cabling and Components Standard
6. TIA-569 – Telecommunications Pathways and Spaces
7. TIA-606 – Administration Standard for Telecommunications Infrastructure
8. TIA-607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
9. TIA-862 – Structured Cabling Infrastructure Standard for Intelligent Building Systems
10. TIA-1152 – Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling

G. Underwriters Laboratories (UL):

1. UL 263 – Fire Tests of Building Construction and Materials
2. UL 1480 – Speakers for Fire Alarm and Signaling Systems, Including Accessories
3. UL 2043 – Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handing Spaces
4. UL 62368-1 – Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements

H. International Code Council (ICC):

1. IBC – International Building Code, 2021 edition (latest)

I. ADA Standards for Accessible Design, 2010 edition (latest)

J. National Electrical Manufacturer’s Association (NEMA)

K. Society of Motion Picture and Television Engineers (SMPTE)

## 1.4 DEFINITIONS

A. The term “Owner” shall refer to New Mexico Department of Agriculture.

B. The term “Architect” shall refer to Dekker Perich Sabatini or the Architect of Record (AOR).

C. The term “Bidder” shall refer to a firm submitting a bid response to this specification.

D. The terms “AV Contractor”, “AVC”, and “Contractor” shall refer to the Audio-Video Systems Contractor who has been awarded the contract for this scope and who has responsibility for the performance of the work specified in this specification.

E. The term “EC” shall refer to the electrical contractor.

F. The term “GC” shall refer to the general contractor.

G. The term “SCC” shall refer to the telecom / tele-data structured cabling contractor.

H. The term “specified elsewhere” shall refer to the material and work which is related to this contract and for which the Contractor is not responsible except as otherwise detailed herein. Some of all of these items may be included in the overall electrical contract.

I. The terms “not in contract” and “NIC” shall refer to work or equipment that is not in the contractor covered in this specification.

J. The terms “owner furnished equipment” and “OFE” shall refer to equipment which shall be provided by the Owner or user to the Contractor.

1. The terms “owner furnished, contractor installed” and “OFCI” shall refer to OFE items that must be physically installed by the Contractor and/or re-cabled or re-terminated and/or re-programmed as part of the new turn-key system. The Contractor shall be responsible for installing OFCI equipment at the project site in good functional order as detailed herein. Where the equipment is existing or is used, the AV Contractor shall verify the operation and functionality of these devices prior to installation.
2. The terms “owner furnished, owner installed” and “OFOI” shall refer to OFE items that do not require any Contractor-provided labor such as installation, re-termination, or re-programming.
3. Unless otherwise indicated, all instances of the terms “owner furnished equipment” and “OFE” shall be interpreted to be synonymous with “OFCI” (owner furnished, contractor installed).
4. Any deficiencies shall be brought to the Owner and Consultant’s attention immediately via written documentation.

K. The terms “provided by others” and “PBO” shall refer to work or equipment that is provided by another trade, party, or team not directly responsible for the Audio-Video Systems but that interfaces with this scope of work.

L. The term “Complete” shall refer to equipment and systems that shall be provided with all necessary accessories to complete a turn-key solution.

1. Example: “equipment racks, complete” that shall include doors, locks, side panels, covers, blank and vented panels, thermal regulation system, cooling fans, cable management, AC power distribution, UPS and power sequencing etcetera.
2. Another example would be control systems that must include all accessories such as RF transceivers, RS-422/485 baluns, distribution amplifiers, PoE power supplies or switches (unless otherwise noted on the one- lines), and external power strips & supplies, cable management etcetera as required providing the Owner with a fully functional and operational turn-key solution. If the Contractor is unclear about a particular piece of

equipment, system accessories, or design intent, then it is the sole responsibility of the Contractor to immediately contact the Consultant via the RFI process for clarification prior to the bid submittal.

M. The term “procure” shall indicate the responsibility to acquire materials, equipment, or services needed to complete the project scope.

N. The term “furnish” shall indicate the responsibility to ship or deliver the item to the job site for receipt, staging and installation by others.

O. The term “install” or “installation” shall indicate the responsibility of receiving the item at the job site, providing adequate storage, unpacking or uncrating the item, physically securing the item or otherwise making ready the item for its intended use by following the instruction and approved methods of the manufacturer and those contained herein.

P. The term “provide” shall refer to the responsibility to both procure, furnish, install, test and certify equipment.

Q. The term “shall” is mandatory; the term “will” is informative; the term “should” is advisory.

## 1.5 SCOPE OF WORK

A. Provide professional grade audio-video systems that promote a quality immersive multimedia educational experience for students, staff, and patrons alike. The AV systems must be modular in concept (expandable) easy to use, set up and maintain by the Owner faculty & support staff.

B. The work as described herein (and within all sub-sections) shall be furnished and installed by one (1) firm alone, hereafter referred to as the AV Contractor or AVC, for undivided responsibility. The AV Contractor shall provide all equipment, cabling and audio / video / control signals for the AV Systems described herein.

C. The work shall be provided complete, and the systems shall be fully operational as shown on the Audio-Video systems drawings. It is expected that the AVC shall be accountable for a functional system regardless of the packages selected by the Owner and that any deficiencies or added expenses created by the Owners’ selections be brought to the AV Consultants and Owners attention before acceptance of the contract.

D. The AV Contractor shall provide equipment and materials, whether specifically mentioned herein or not, to ensure a complete and operating system. Equipment and materials designated as PBO, NIC, and/or OFE are specifically exempted from this requirement. If the Contractor is unclear about a particular piece of equipment, system accessories, or design intent, then it is the sole responsibility of the Contractor to immediately contact the Consultant via the RFI process for clarification prior to the bid submittal.

E. The AVC shall provide all software programming required to provide fully operational systems.

F. It is expected that the Contractor shall be accountable for a functional system regardless of the packages selected by the Owner and that any deficiencies or added expenses created by the Owners’ selections be brought to the AV Consultants and Owners attention before acceptance of the contract.

G. The specifications and drawings shall be read and used together. System features which are mentioned in one are not necessarily shown in the other. In case of conflict between the drawings and specifications, request clarification via the pre-bid RFI proves. These pre-bid RFIs are due one (1) week before the bids are due. All pre-bid RFI responses shall be distributed to each Bidder.

H. The AVC shall coordinate with the Owner and/or their network staff etcetera to fully understand their network protocols and the security feature set they utilize so that the AV Network shall be installed and remain secure to outside cyberthreats at all times.

## 1.6 BID ALTERNATES

A. Any line-item alternates described shall be priced assuming that the Owner will accept or decline the alternate at time of contract award. Do not add any additional freight/shipping, or labor assuming an additional trip or change order.

## 1.7 SEQUENCING AND SCHEDULING

A. All work shall be reviewed and coordinated with the Owner prior to commencing work.

B. Coordinate installation with Broadcast Lighting Systems, Structural, Electrical, Mechanical, Plumbing, Fire Protection, IT / Tele-data, Security and other trades to eliminate disruption and/or conflict with other systems.

C. Sequence installation of the AV systems and infrastructure with other work to minimize possibility of damage and soiling during remainder of construction.

## 1.8 RELATED WORK BY OTHER TRADE CONTRACTORS

A. General Contractor: It is the responsibility of the GC to furnish and install all steel not shown on the Structural drawings but required for the Audio-Video equipment rigging and support. Additionally, the GC shall provide plywood backing to support video flat panel monitors, video walls, etc.

B. Electrical: It is the responsibility of the EC to furnish and install the work described in the Electrical documentation. All high-voltage work shall be done by the EC only.

C. Tele-data: It is the responsibility of the Tele-Data / IT Contractor to furnish and install network data drops (including those designated as Dante signal types) and wireless LAN access point equipment that shall be utilized by the AV Systems and one-line diagrams. AVC shall closely coordinate their requirements with the Tele-Data Contractor.

D. Fire Alarm / Life Safety: The AVC shall coordinate the requirement of a contact closure & relay device from the Fire Alarm Panel to the AV Systems as indicated on the Audio-Video one-line diagrams. It is required so that the AV System shall mute during an “event”. The AVC shall install the control cabling from the FA Contractor’s addressable relay to the AV system(s).

## 1.9 MILESTONES

A. CA Kick-Off Meeting: Upon the contract award, and within twenty (20) working days, the AV Contractor shall initiate / set-up a meeting to discuss the project scope of the work, general project expectations and, but not limited to the following agenda items:

1. AV System Functionality
    a. Audio DSP programming, presets and operations
    b. Control system functionality / preliminary discussions
2. Shop Documentation and Submittal Schedule
3. Installation Schedule / Timetable
    a. Equipment delivery issues / lead times (if any)
    b. Substantial Completion
    c. Final Acceptance Testing
4. As-built Documentation
5. Owner Training

B. Control System Functionality Meeting: The AV Contractor shall initiate / set-up a meeting with the Owner and AV Consultant prior to submitting the GUI for approval. This meeting will help the AV Contractor understand the Owner's requirements and how they plan to use the various spaces in this facility.

1. It shall be noted that the Owner can request an additional set of changes to the touch panel GUI layout, operation and functionality of the controls system once the system is operational and the Owner has access to verify their anticipated functionality requirements. Typically, this would occur during the second training event and after the Owner and staff have had the opportunity to use the fully operational system.

C. Electrical Infrastructure Site Survey: The AVC shall coordinate an electrical infrastructure & box site survey (box walk) with the GC & EC prior to the installation of drywall and ceiling and /or hard lid ceilings. AVC shall issue a report as to their findings to the OAC team so that identified issues can be resolved in a timely manner prior to the installation of the drywall or wall finishes etcetera.

## 1.10 PRE-BID SUBMITTALS

A. Submit in accordance with Division 1 Section 01300 Submittals.

B. AV Contractor Qualification Statement: Non-pre-qualified AV Contractors shall submit for approval a statement of the AV Contractor's qualifications.

1. All certifications and licenses shall be current. Proof must be provided.
2. At a minimum, this submittal shall include the following:
3. A list of AV systems of comparable size and scope to that described herein, completed by the AV Contractor within the last five (5) years. Provide the project name, address, year of

completion, and the name and telephone number of a person to contact who is a representative of the facility.

4. Project Engineer: A personal resume of formal education and experience of the qualified staff engineer who would direct the work. This person shall be a licensed Professional Engineer (PE) and / or be certified as an AVIXA CTS-D.
5. Project Manager: At least one (1) person involved in the daily installation of these systems shall hold an AVIXA CTS-I certification.
6. Programmer: Software programmer must hold a current Dante Level 3 certification and have extensive experience in the deployment of complex Dante Domain Manager installations. The programmer shall also be fluent in all control system, and other complex electronic device programming as required by this project.
7. A description of the AV Contractor's capabilities and facilities for rack assembly, shop fabrication, software programming, repair, and servicing of AV systems.
8. A letter from the control system manufacturer(s) certifying that the AV Contractor's software programmers have been factory trained and are qualified to provide the proposed installation.
9. Current documentation of the following manufacturer certifications and training for the staff that shall be engaged throughout the project. The certification must be held by the AVC for no less than one (1) year prior to this bid submittal.

| *Manufacturer* | *Certification* |
|---|---|
| Crestron / General | Master Technology Architect (MTA) |
| Crestron / Control System | Master Certified Programmer (MCP) |
| Crestron / Design & Technician | Design Certification + Technician Certification |
| QSC/QSYS / Audio DSP | Qsys Level II, Qsys Control 201 |
| Audinate / Dante | Level 3 |

## 1.11 SUBMITTALS

A. Submit in accordance with Division 0 & 1 – SUBMITTAL PROCEDURES.

B. Long Lead-Time Items: Prior to submittal of Shop Documentation, and within one (1) month of contract award, the AVC shall submit a list of anticipated long lead-time items (i.e., items with a lead time of 8 weeks or longer) for early approval. It is expected that all items listed in this submittal be furnished immediately upon approval.

C. Shop Documentation:

1. The AVC shall submit both the Product Data, Bill of Materials and Shop Drawing submittal(s) simultaneously, no exceptions.

2. Bill of Materials (Equipment/Cabling/Materials List or Schedule): A complete list with quantities of equipment to be provided for the systems, including that required for items which are to be fabricated by the AV Contractor (i.e., a bill of materials). Products shall be listed in the same order as found herein. No exceptions.

D. Product Data: Submit product data sheets for each product to be used, including:

1. A complete set of manufacturer's equipment specifications with detailed technical information describing and illustrating all components and materials to be used in the installation of the AV systems. This would include those items listed by manufacturer and model number herein and any other components needed to provide complete functional systems.
2. Preparation instructions and recommendations.
3. Storage and handling requirements and recommendations.
4. Installation methods.

E. Wireless Microphone Frequency Coordination:

1. Provide on-site scan of UHF radio spectrum, from 470-608 MHz, using a calibrated spectrum analyzer (i.e., RF Venue). Show the noise floor in dBm with a horizontal line.
2. Using the scanned spectrum as well as the digital television (DTV) station database information available from the microphone system manufacturer's website, determine the specific frequency bands best suited for the project, to minimize intermodulation distortion and channel conflicts, and maximize channel count. Include the specific frequency band for each component on the shop drawings (below).
3. Submit proposed frequencies for each channel of wireless microphones within the proposed frequency band, taking into account second- and third-order harmonics to prevent intermodulation distortion, and avoiding DTV stations. Indicate and include any additional sources of RF in the space, such as in-ear monitors (IEMs), wireless intercom headsets, etcetera. Provide at least 1 spare frequency for every 4 channels of wireless microphones.

F. Shop Drawings: The shop drawings shall be submitted after the award of contract and be of a scale suitable for use for fabrication. The AVC shall maintain on-site a hardcopy of their shop drawings detailing the latest as-built conditions. AV Contractor shall make the following shop drawings submittals:

1. A complete set of shop drawings of items which are to be fabricated by the AV Contractor and/or which the AVC intends to fabricate or has fabricated, including, but not limited to, the custom panels and receptacle plates. They shall show materials, finishes, panel/control markings, and complete dimensions when applicable.
2. A one-line signal flow interconnect diagram showing exactly the manner in which the AV Contractor proposes to install the system. Show all dip switches, modifications to equipment, relay and control circuits. Show all equipment/apparatus items which are required for realization of the functions described herein.
3. Cabling Schedule: A complete materials list containing cable type, cable marker identifier, connector type, and origin and destination location for each cable.

4. Any wireless microphone or monitor system shall indicate its proposed frequency band (such as G50 or J50A) on the one-line signal flow interconnect diagram.
5. Detailed diagrams showing loudspeaker mounting details with all hardware identified by manufacturer and model number.
6. A signal loss diagram for the coaxial distribution of video signals with calculations to verify that the signal strength at each endpoint is within industry specifications.
7. Sight-line calculations regarding FDA 3640 with elevations drawings of each location where a laser projector is to be installed and how its light path does not provide a hazard to human sight.
8. Detailed diagrams showing equipment rack layouts.
9. AVC shall maintain on-site a hardcopy of their shop drawings detailing the latest as-built conditions.

G. Control & DSP System Shop Submittal:

1. GUI layouts that demonstrate page flips and system operation.
2. Compiled and executable code of all control systems and digital signal processing (DSP) systems for consultant review. In DSP configuration, unity gain staging shall be applied (i.e. all stages of gain shall be set to 0dB attenuation).
3. Dante Domain Manager/Dante Controller routing maps.

H. Written field updates, including photos etcetera (once the site installation begins) shall be required every two (2) weeks.

I. Audio system acoustical testing and tuning / optimization report. Refer to part 3.11.

J. Closeout Documents: Prior to Final Acceptance, AV Contractor shall submit the following:

1. Test reports, as specified herein. These documents are required twenty-one (21) calendar days before the anticipated final acceptance testing, else the appointment shall be rescheduled.
2. Updated control system and DSP source code and executable files, with all tunings and adjustments incorporated.
3. Updated frequency coordination, including specific “real world” frequency selection, showing no intermodulation distortion or channel conflicts.
4. Complete and accurate Final As-Built Drawings prior to final acceptance testing.
5. O & M manuals / documentation, programmable software files and executables as specified herein.
6. Quick-Reference Guide Manual.
7. Recordings of Owner Training Sessions.
8. Written warranty, as specified herein, to take effect after the Consultant Final Acceptance Testing has occurred and any punch list-items have been completed

## 1.12 QUALITY ASSURANCE

A. Manufacturer's Qualifications: All electronic products shall be designed and marketed by the manufacturer for application in professional sound amplifying, reproduction and recording systems.

B. AV Contractor's Qualifications: All certifications and licenses shall be current. At a minimum, the AVC shall provide documentation demonstrating compliance with the following requirements:

1. A list of AV systems of comparable size and scope to that described herein, completed by the AV Contractor in that last five (5) years. Provide the project name, address, year of completion, and the name and telephone number of a person to contact who is a representative of the facility.
2. Project Engineer: A personal resume of formal education and experience of the qualified staff engineer having five (5) years minimum experience who would direct the work. This person shall be a licensed Professional Engineer (PE) and / or be certified as an AVIXA CTS-D. In place of a qualified staff engineer, the AV Installer may retain a consulting engineer to direct the project. The staff or consulting engineer shall:
    a. Provide all technical liaison between the AV Contractor and the Construction Manager.
    b. Represent the AV Installer at meetings and conferences and be present at the job site for final inspection.
    c. Be responsible for the supervision of all technical and engineering work required to execute the contract and approve and sign the shop drawings.
    d. The staff engineer shall remain on the project (at a minimum) in a supervisory role until the completion of all AV-related work.
3. Project Manager: At least one (1) person involved in the daily installation of these systems shall hold an AVIXA CTS-I certification.
4. Programmer: Software programmer must hold a current Dante Level 3 certification and have extensive experience in the deployment of complex Dante Domain Manager installations. The programmer shall also be fluent in all control system, and other complex electronic device programming as required by this project.
5. A description of the AV Installer's capabilities and facilities for rack assembly, shop fabrication software programming, repair, and servicing of AV systems.
6. A letter from the control system manufacturer(s) certifying that the AV Installer's software programmers have been factory trained and are qualified to provide the proposed installation.
7. Current documentation of the manufacturer certifications and training for the staff that shall be engaged throughout the project. The certification must be held by the AVC for no less than one (1) year prior to this bid submittal.

C. System Performance Testing: The AV Contractor's commissioning team members shall be certified as an AVIXA CTS-I.

D. Minimum Performance Requirements: To meet the minimum performance requirements, the AV Contractor shall be responsible for:

1. Installing Assistive Listening System components in conformance with 2021 IBC Chapter 11 Section 1109.2.7 “Assistive Listening Systems”, as well as with 2010 ADA Standards for Accessible Design Section 219 “Assistive Listening Systems”.
2. Each component’s conformance with the manufacturer’s published specifications and other requirements as stated herein.
3. Detailed checking of each piece of equipment provided, each portion of the installation, and of the complete installation to find and remedy any defects therein.
4. Setting the system gain structure, including initial adjustment of digital signal processing, and amplifier gain controls, and, under the direction of the Consultant, making the final adjustment of these items and, if so directed, re-aiming loudspeakers, resetting loudspeaker levels and providing additional equalization and DSP programming, as necessary.

E. Final Acceptance: Final Acceptance will be contingent upon issuance by the AV Consultant of a letter of acceptance stating that the work has been completed and is in accordance with the contract documents. This is when the warranty period shall begin and not at “Substantial Completion”.

## 1.13 DELIVERY, STORAGE, AND HANDLING

A. AV systems, infrastructure, raceways and equipment are sensitive to environmental conditions such as temperature, dirt, dust, and water. The AV contractor shall ensure the storage and installation of all AV Systems components are sequenced and scheduled accordingly to prevent any damage, loss of performance, and warranty void of such systems. All miss-installed components shall be replaced with new parts and re-installed at the AV Contractor’s expense.

B. The AV Contractor shall ensure the storage and installation of all AV Systems components are sequenced and scheduled accordingly to prevent any damage, loss of performance, and warranty void of such systems.

C. All incorrectly installed components shall be replaced with new parts and re-installed at the AV Contractor’s expense.

## 1.14 WARRANTY

A. Provide a written warranty, signed by the AV Contractor, due when the AVC issues the As-Built Documentation. The warranty period shall equal the requirements described the DIVISION 00 sections.

B. Include the following provisions:

1. Warranty all equipment and the installation to be free of faulty workmanship.
2. Warranty all components, including solid state devices, to be free of defects.
3. Paint and exterior finishes, fuses and lamps are excluded from above warranty, except when damage or failure results from defective materials or workmanship covered by the warranty.

C. If, within the warranty period of the installation or within a longer period of time as may be prescribed by law or by the terms of any applicable special warranty required by the Contract Documents or provided by a manufacturer, any of the work or equipment is found to be defective or not in accordance with the Contract Documents, the AV Contractor shall correct it promptly including all parts and labor after receipt of notice from the Owner to do so unless the Owner has previously given the AV Contractor a written acceptance of such condition. This obligation shall survive termination of the contract. The Owner shall give such notice promptly after discovery of the condition. Such notice shall be provided by Owner representatives, to be identified, either verbally or in writing.

D. Nothing contained in the Contract Documents shall be construed to establish a shorter period of limitation with respect to any other obligation which the AV Contractor might have under the Contract Documents or any manufacturer's warranty. The establishment of the time period noted above, after the date of Final Acceptance or such longer period of time as may be prescribed by law or by the terms of any warranty required by the Contract Documents, relates only to the specific obligation of the Contractor to correct the work or equipment, and has no relationship to the time within which their obligation to comply with the Contract Documents may be sought to be enforces, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to their obligations other than specifically to correct the work or equipment.

E. The Owner reserves the right to expand or add to the system during the warranty period using firm(s) other than the AV Contractor for such expansion without affecting the Contractor's responsibilities, provided that the expansion is done by a firm which is an authorized dealer or agent for the equipment of system being expanded.

F. Structured Cable:

1. The manufacturer shall provide a warranty with a minimum term of twenty-five (25) years for structured cabling and all communications cable infrastructure components. This warranty shall cover all components including cables, jacks, patch panels, and wiring panels, etc. to maintain the specified performance, physical criteria, and applications assurance.
2. Any such components, link, or channel shall be replaced by the manufacturer at no cost to Owner during this period.
3. The Contractor and Manufacturer shall submit all information and documentation on Warranty

G. Service Warranty:

1. Replace defective materials and repair faulty workmanship within 72 hours of discovery at no cost to the Owner during the period of the Warranty.
2. If during the warranty period, system operation is not fully restored, or a working temporary solution is not deemed acceptable by the Owner, within four (4) business days, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.
3. At no additional charge, provide maintenance service for a period of one (1) year after the AV Consultant's Final Acceptance of installation. This service shall consist of at least one (1) visit six (6) months and one (1) visit eleven (11) months after Final Acceptance for regular maintenance responsibilities, checking equipment and systems operations /

functionality, and rigging safety. The AVC shall make all necessary adjustments in a timely manner.

4. If, during the warranty period, any component is out of service for more than four (4) days due to unavailability of parts or service, supply and install an identical new component. If an identical component is not available, temporarily substitute equivalent equipment, but only with the written approval of the Owner.

## PART 2 PRODUCTS

### 2.1 MATERIALS

A. Unless otherwise indicated, equipment in this Section shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. All components used in the system shall be commercial designs that comply with the Specifications.

B. All materials, equipment and apparatuses shall be new and of the latest design or model offered for sale by the manufacturer.

C. Each major component of equipment shall identify the manufacturer's name, model and serial number. Items of the same classification shall be identical. This includes equipment, modules / cards, parts, and components.

D. Principal items of equipment and apparatuses are identified herein by part number and manufacturer. Alternate part numbers and manufacturers are identified in instances in which equivalence has been determined.

E. Acceptability for use in the systems shall be determined by the AV Systems Consultant. Such items shall be installed only after receipt of written approval. The Consultant retains the right to reject products which reflect, in the Consultant's opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

### 2.2 SUBSTITUTE EQUIPMENT

A. AV Contractors who wish to provide substitution options to the base bid may do so by providing a completely separate and discrete bid document in addition to the original bid documentation.

B. All substitution devices shall provide equal or better electronic or acoustical performance than the originally specified devices. This submittal would require a new EASE model for any proposed loudspeaker(s) to verify compliance with the Construction Documents where necessary.

C. The AV Consultant shall be the final judge regarding the validity of substitution bid data submitted. Acceptance of any / all substitutions shall be under the direction of the consultant only, who may or may not accept the substitution with or without explanations. The consultant approvals or rejections shall be noted as final. No exceptions.

## 2.3 MANUFACTURERS QUOTES

A. Though manufacturers may provide quotes for equipment intended for use in this scope of work, it is the responsibility of the AVC to verify the completeness of any such quotes / documentation as they are solely responsible for any discrepancies that arise during the shop drawing proves and installation. No additional requests for payment after the bid award with regards to manufacturer quote discrepancies will be accepted.

## 2.4 DEVICE QUANTITIES

A. Every attempt has been made to provide an accurate and detailed equipment schedule. However, when a discrepancy is found, the quantities found on the one-lines shall take precedence over the equipment schedule specified herein. AVC shall issue a pre-bid RFI requesting clarification no later than five (5) working days prior to the bid due date. Responses shall be provided to all bidders prior to the bid due date.

## 2.5 EQUIPMENT SCHEDULES

A. Refer to Section 274100.10 for Audio-Video Equipment Schedule related to Test Kitchen and Recording Suite.

B. Refer to Section 274100.20 for Audio-Video Equipment Schedule related to Conference Rooms and Other Spaces.

## 2.6 EQUIPMENT PERFORMANCE SPECIFICATIONS

A. For all items which are identified by part number and manufacturer, performance specifications which are published in the most recent manufacturer's data sheets available at the time of bidding this contract shall be applicable to the present work as though fully written out herein.

B. For those items which are not identified by part number and manufacturer, the AV Contractor may select items which conform to the functional and/or technical specifications. For all such items, the AV Contractor shall submit for approval all technical data which is available from the supplier or manufacturer.

C. All terminated and bulk cable types shall be submitted in the shop documentation prior to purchase and installation.

## 2.7 WIRING AND CONDUCTORS

A. General Notes:

1. Any specific cable AWG gauge detailed in the drawing package supersedes this document. These cable types are cited to illustrate the type and quality of cable required. Plenum cable must be utilized as required. Unless otherwise noted, cables from other reputable manufacturers will be considered acceptable only if data sheets are submitted and approved by the AV Consultant prior to installation. The AV Contractor must verify cable lengths and confirm the suitability of the cables listed above but may change based

on field conditions. Where signal loss is beyond anticipated norms, the AVC shall coordinate with manufacturers and the AV Consultant to select a cable that will meet or exceed the requirements. No exceptions.

2. Cables running in plenum areas without conduit shall be plenum rated cable and match the specified cable below. It is the responsibility of the bidder to inspect the electrical drawings and verify in what spaces plenum cable shall be used. No claims for additional monies, based on the use of plenum cable, will be allowed.
3. All cables (except video and pulse cables which must be cut to an electrical length) shall be cut to the length dictated by the run. No splices shall be permitted in any pull boxes without prior permission of the AV Consultant. For equipment mounted in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length based on the bend radius of the cable etcetera.
4. All cable that shall be used in outdoor applications shall be tactical / outdoor rated weather block cable and all connectors shall also be outdoor rated Neutrik “True Outdoor Protection” terminations where applicable.

B. Category Cable:

1. All channels, including patch cords, patch bays, etcetera must not exceed the 100-meter length. If it is determined in the field that a run will exceed this distance, immediately contact the AV Consultant for consultation and direction. No exceptions.
2. 4k / 8k DigitalMedia (DM) or HDBaseT Video Applications: Shielded twisted pair cable shall be installed in metallic conduit and shall be Belden 2183P or 2183R, including shielded terminations, or consultant accepted equivalent.
3. Dante, AES67, NDI, and other audio or video over IP Applications: CAT6A, unshielded twisted pair cable shall be installed in metallic conduit and shall be Belden 10GX12 CMP, or consultant accepted equivalent. AVC shall terminate all cable using PCB type (Belden REVconnect) connector, using “flexconnect” in difficult to access terminations.
4. Control/Network Applications (not audio or video streaming): CAT6+, unshielded twisted-pair cable shall be installed in metallic conduit and shall be Belden 2433 CMP, or consultant accepted equivalent. AVC shall terminate all cable using PCB type (Belden REVconnect) connector, using “flexconnect” in difficult to access terminations.
5. Outdoor / Tactical Applications: Includes but are limited to the following:
    a. Data: CAT6A Belden OSP6AU
    b. CAT6A (4k video) Belden 2141A

C. Coaxial Cable:

1. All wireless remote antenna coaxial cables shall utilize 50.0 ohm cables and terminations and shall be the products listed below or approved equivalent.
    a. Belden 9913
    b. ECORE: EMR-400
    c. Time Microwave: LMR400
2. Unless otherwise noted, all analog video and ASTC CATV cables are to be terminated using 75.0 ohm connectors.

3. Multichannel Audio Digital Interface (MADI): Belden 1505A

D. Balanced Line Level Cable: Line level cable shall be UL Listed NEC Type CM, PVC jacketed 22 AWG strand pair conductors with overall shield and shall be Belden No. 9451/9451P, or accepted equivalent.

E. Loudspeaker Cable: Includes but are limited to the following:

1. Low impedance loudspeaker cable installed in metallic conduit shall be UL Listed NEC Type CL3 jacketed 12 AWG (or 10 AWG as recommended by the manufacturer) stranded pair conductors and shall be Belden 5000/6000 UE, or consultant accepted equivalent.
2. 70V/100V distributed loudspeaker cable not installed in conduit shall be plenum rated and shall be Belden 5100/6100 UE, or consultant accepted equivalent.
3. Loudspeaker cable utilized for outdoor applications (even within conduit) shall be tactical and/or waterproof in nature and rated as such by the manufacturer.
4. Outdoor Rated Cables: includes but are not limited to the following:
   a. 10 AWG Belden 8810WB
   b. 12 AWG Belden 5000U1
   c. 14 AWG Belden 5100U1
   d. CAT6A (4k video) Belden 2141A

F. Control System Cable: Remote volume controls shall be installed in metallic conduit and shall be Belden No. 1502P, or consultant accepted equivalent.

G. HDMI 2.0 pre-terminated cables shall be Extron Ultra / Pro series, or Consultant accepted equivalent. Utilize HDMI 2.1 series cable when available.

## 2.8 FABRICATED MATERIALS

A. Designation / Engraving

1. All equipment controls, receptacles and all indicators shall have, unless otherwise noted, Lamacoid / Phenolic, permanently engraved, or silk-screened fully descriptive identification labels. The resolution of silk-screened labels shall not be less than 90,000 dots/sq. in.
2. The word “engraved” shall mean that the identification shall be engraved into the indicated panel, plate or control surface.
3. All engraving shall be with 5/32-inch high characters, unless otherwise noted, and shall be filled with engraver’s enamel of a contrasting color.

B. Receptacle Plates:

1. Receptacles shall be screwed, bolted or flush-riveted to the plate.
2. Plates shall be marked to indicate function and circuit of the receptacle, for example: MICROPHONE. Each receptacle shall have a discrete and unique identifier, for example: MIC 1, MIC 2, etc. All identifiers shown on the Contract drawings are for reference only.

3. All wall plates shall be powder coated rather than having an adonized finish.
4. Color and finish of blank panels and custom assembly panels shall match adjacent equipment panels to the extent possible. The finish of wall mounted receptacle panels shall be coordinated with the Architect.

C. Terminals and Terminations:

1. Microphone cables shall not be spliced or otherwise interrupted from termination to termination. All cables shall have visible adhesive identifying markers on each end.
2. Wiring in terminal cabinets shall be tied and clamped neatly to backboards or cable-forms.
3. Terminals shall, unless otherwise specified, be one of the following types:
   a. Wire-wrap type terminal block.
   b. Barrier strips with screw terminals.
4. Each terminal strip shall have a legibly marked identification strip.

D. Structural Assemblies:

1. Provide holes required for securing other components or assemblies to structural steel framing and for passage of other components through steel framing members as shown on final shop drawings. Cut, drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning.
2. In fabricating mounting brackets and other steel components requiring bends, the radii of the bends shall not be less than three times the thickness of the steel being bent.
3. All bolts and nuts used in the fabrication of mounting hardware shall be Grade 5 or better, i.e. rated five (5) times the anticipated load.

## PART 3 EXECUTION

### 3.1 INSTALLATION PRACTICES

A. The AV Contractor shall coordinate with EC on conduit/junction box locations for audio equipment and routing of audio, control, and power cables/conduits from terminals, poke-thru /floor and pull boxes, wall plates, stub-ups etcetera to system equipment racks. This shall be done prior to the installation of drywall, ceilings etcetera.

B. Installation shall include the delivery, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system components, equipment alignment and adjustment, and all other work whether or not expressly required herein which is necessary to result in complete operational systems.

C. Contractor shall construct AV equipment racks and sub-assemblies, including all equipment to be installed therein off-site. All wiring work, labeling of wiring, cable dressing, hardware supports, and connection panels, cable wiring documentation, socket installation, ventilation and power supply regulation and filtering component installation shall be performed in AV Contractor's own premises.

D. The Contractor shall not deliver equipment in original packaging to the site for installation. All such equipment will be unpacked and checked thoroughly in AV Contractor's premises. Contractor shall test such equipment as it is received to ensure that it conforms to the manufacturer's specifications. On no account shall the Owner be liable for any delays of completion of the installed system due to defective equipment being received by Contractor.

E. Keep the job adequately staffed at all times. Designate a field supervisor to be present on the job site and in responsible charge during all phases of installation and check out. Maintain the same supervisor throughout the execution of the work unless circumstances beyond the control of the AV Contractor intervene. Install the system in cooperation with other trades in order to achieve coordinated progress and satisfactory final results. Watch for conflicts with work of other trades on the job. Execute without claim for extra payment, moderate moves or changes as are necessary to accommodate other equipment or preserve symmetry and pleasing appearance.

F. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors. Any issue regarding a visual aesthetic shall be brought to the attention of the GC and Architect immediately so that all parties can coordinate and provide an adequate solution in a timely manner.

G. For the purposes of coordination with Architects specified furniture, the AV Contractor will ensure that such equipment or mounting hardware is compatible with and suitable for installation in that furniture. It shall be the AV Contractor's responsibility to ensure they coordinate with the furniture and / or millwork contractor and that parties shall exchange and follow their Shop Drawings to ensure that dimensions and structural supports are adequate for the AV equipment installation. It is the AV Contractor's responsibility that the request and delivery of such critical coordination information is satisfactorily executed and in as much as the Contractor has control over the delivery of such information, the AV Contractor shall deliver it as requested by the Architect.

H. The equipment specified herein must be capable of operation in environments of normal humidity, dust and temperature. AV Contractor should avoid installing equipment where extreme environmental conditions can occur and shall be responsible for protection of equipment and related wiring from such conditions.

I. The AV Contractor shall take precautions to prevent electromagnetic and electrostatic hum. Install the equipment to provide safe operation. Provide ventilation as required to maintain equipment within the manufacturer's specified temperature limits.

J. The AV Contractor shall do all cutting and patching necessary for proper installation of the system and shall repair any damage done by themselves or their workmen. Any required penetration of slabs or CMU walls shall be made by a cutting method rather than by a concussive method.

K. All installation practices shall be in accordance with, but not limited to, the general design and construction requirements of the Architect, and these specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements and recommendations of local authorities having jurisdiction (AHJ). Before commencing work, the Contractor shall familiarize all project team members with all of these requirements.

L. If, in the opinion of the AV Contractor, an installation practice is desired or required, which is contrary to these specifications or drawings, a written request for modification shall be made to

the AV Consultant and / or Architect. Modifications shall not commence without written approval.

M. During the installation, and up to the date of issuance of the Final Acceptance Memorandum, the AV Contractor shall be under obligation to protect their finished and unfinished work against damage and loss. In the event of such damage or loss, they shall replace or repair such work at no cost to the Owner.

## 3.2 GENERAL INSTALLATION PROCEDURES

A. Locate all apparatuses requiring adjustments, cleaning or similar attention so that they will be accessible.

B. All boxes, equipment, wall plates, loudspeakers, antennae, cabling etcetera shall be secured plumb and square.

C. All supporting structures and enclosures supplied by the AV Contractor, not having a standard factory paint finish, shall be painted. Paint specifications and color shall be supplied by the Architect.

D. Clearly, logically and permanently mark switches, connectors, jacks, relays, receptacles, cables and cable terminations.

E. Etch, engrave, silk screen or apply in a similar permanent manner all legends and markings on all custom panels and receptacle plates. Embossed tape, press type, etc., are not acceptable.

F. Provide all cables necessary for interconnection of permanently mounted equipment. Use terminations required to achieve full function of equipment as specified herein.

G. Exercise care in wiring, to avoid damage to the cables and to the equipment. Make all joints and connections with rosin-core solder or with mechanical connectors approved for Class I wiring. Execute all wiring in strict adherence to standard broadcast and BICSI procedures. AVC shall adhere to the cable manufacturers' recommended cable bend radius, no exceptions.

H. Run lines in separate metallic conduits for line level circuits (up to +30.0 dBm), loudspeaker circuits (above +30.0 dBm) and power circuits. Non-metallic or PVC conduits for AV system wiring are not acceptable. Confirm with EC that all metallic raceways have been properly bonded. Use only cables which are insulated from the conduit and from each other for the entire conduit length.

I. All shielded audio cable shall be bonded at both ends. Do not ground audio cable shields only at the source end. Preserve continuity of microphone shields at both connecting points. Connect all audio grounds in this system to a common point.

J. All equipment shall be firmly secured in place unless the equipment has been documented to be portable in nature, either within this Specification or as shown in the Construction Documents.

K. All fastenings and supports shall be adequate to support their loads with a safety factor of five (5) times the load weight or as required by ESTA , whichever is greater. Wind shear must be taken into account when installing all outdoor pole mounted devices.

L. All loudspeakers shall be installed according to the manufacturer's instructions. All loudspeakers shall be installed with a secondary seismic safety harness assembly in addition to the specified loudspeaker mount. No exceptions.

M. It is the responsibility of the AVC to test all loudspeakers and/or loudspeaker line arrays for sound pressure levels to verify that the full frequency spectrum coverage area is uniform throughout the listening area. AVC shall reposition and or adjust aiming angles as necessary until uniform full frequency coverage is reached per the specification. This work shall be done as part of this contract and no additional funds shall be provided to the AVC to accomplish this requirement. No exceptions.

## 3.3 COORDINATION:

A. All work shall be reviewed and coordinated with the GC prior to commencing work.

B. The AV Contractor shall coordinate all AV equipment connections, panels and control locations with the Architect prior to installation.

C. Coordinate installation with Structural, Electrical, Mechanical, Plumbing, Fire Protection, and other trades to eliminate disruption and/or conflict with other systems.

D. Sequence installation of the AV Systems and infrastructure with other work to minimize possibility of damage and soiling during remainder of construction.

## 3.4 STRUCTURAL INSTALLATION REQUIREMENTS

A. It is the GC's responsibility to provide structural support elements for the mounting of audio-video equipment. AVC shall closely coordinate with the GC regarding structural support required to safely install the AV equipment as needed.

B. Structural support elements are defined as those materials added to the structure for the reinforcement of general construction methods to meet a designed minimum load factor of five (5). These include but are not limited to:

1. Backing boards / plywood required for the support of audio-video equipment or cabling.
2. Strut supports hung from structural beams or concrete slab.

C. The AV Contractor shall provide all audio-video mounting and rigging equipment that fasten to the structural support elements.

D. All support elements and fastenings shall be able to support a minimum load factor of five (5) times the total assembled weight.

E. The AV Contractor shall be responsible for the complete and correct installation of all the audio-video equipment.

F. Hard Ceiling Lid Loudspeaker Locations: Hard lid ceiling loudspeaker locations requiring trim rings, rough-in brackets, and back boxes shall be installed during conduit installation where possible.

1. The Contractor shall install the trim rings, rough-in brackets, and back boxes for hard ceiling locations in a timely manner, not to conflict with scheduled work of other trades. In the event that this equipment is not installed in a timely manner, the Contractor shall be responsible for all retrofit work and materials to provide a fully functioning speaker assembly.

G. Trim and Escutcheon Components:

1. To ensure a proper finished appearance, the AV Contractor shall furnish and install trim / escutcheon components in all conditions where AV components pass through the finished walls, floors and ceilings. This would include but not be limited to video projector supports, video flat panel monitors, control panels etcetera for supports which are not specifically supplied with integral flanges / trim components.

2. The visible component of any trim shall be as small as possible, preferably no wider than 1/2-inch. All trim components at the ceiling plane shall be finished to match the approved ACT ceiling grid system components. The AVC shall obtain a sample from the GC, including any custom color information, or standard color numbers. All trim components shall be submitted to the Architect for review and approval prior to fabrication.

## 3.5 BONDING

A. The Contractor shall be responsible for correcting any signal grounding problems within the AV System (excluding Division 26 grounds) including but not limited to electromagnetic / electrostatic hums, ground loops anomalies, and distortions.

B. A bonding buss bar shall be installed at each equipment rack location. The copper buss bar shall be sized to accommodate all connections plus future expansion. See drawing details for additional information.

C. In locations where multiple AV equipment racks exist, they shall be grounded to each other as well as grounding to the AV Grounding Bar (AVGB).

D. Ground all components according to the following methods:

1. Equipment having a power cord without a grounding conductor connected to chassis: Furnish and install 14 AWG grounding conductor from the component’s metallic chassis to grounding buss bar within rack.

2. Equipment having a power cord with a grounding conductor connected to chassis: Do not install an additional grounding conductor.

E. Shielded audio signal cables shall have the shields terminated at both ends. No exceptions.

F. All video and data shielded cables shall have the shielded conductors terminated on both ends.

## 3.6 NETWORK REQUIREMENTS

A. The Contractor shall coordinate with the Owner regarding the Ethernet switch requirements and system topography necessary for the AV Systems:

1. 1 G Ethernet switches for audio systems.

2. 10 Gbps Ethernet switches for video, video conferencing, and media server equipment.
3. IP Address quantity for AV System
4. Wireless access points for dedicated AV Systems.

## 3.7 PATCH PANEL ASSIGNMENTS

A. The Contractor shall provide patch panels that shall be the same category as the cable being passed through them and match the more stringent category rating if multiple cable types are terminated there. The AVC shall provide shielded terminations that also match the category of the most stringent cable type.

B. All patch panels shall be wired so that the signal “sources” (outputs from) appear on the upper row of a row pair; and all “loads” (inputs to) appear on the lower row of a row pair.

C. All audio and video patch panel designation strips shall utilize alphanumeric identifications and descriptive information. The jack position in each horizontal row shall be numbered sequentially from left to right. The horizontal jack rows shall be lettered sequentially from top to bottom. The alphanumeric identification of each jack shall be included on the shop documentation functional block drawings, as well as on reproductions of these drawings, which shall be mounted in an appropriate location near the patch bays.

## 3.8 CONTROL SYSTEM PROGRAMMING

A. General:

1. Where specified, the AV Contractor shall provide a control system interface for mechanical or electronic devices such as motorized projection screens or room lighting. Wherever possible, mechanical devices shall include a “Stop” button to halt motion in addition to buttons to drive normal equipment operation.
2. A “Quit” or “System Shutdown” button shall be available from the main menu. When the User has selected this button, a confirmation screen will be displayed indicating that the shutdown sequence has been selected. A second button press shall be required to initiate the power down sequence.
3. A message will pop-up reminding the User to halt all recordings, as well as to remove all media such as DVD or Blu-Ray discs.
4. If a lamp-based component such as a video projector has a significant cool-down and warm-up time between its on and off state, the warning should indicate that this particular device will be unavailable for a specified period of time.
5. For divisible spaces: If the system is currently configured to run in “divided” mode, then separate “power up” and “power down” sequences shall be provided, thus allowing one room to be powered on, while the other room is powered down.
6. If so requested by the Owner, all o some of the control system processors shall be programmed with an Auto Shutdown feature. Auto Shutdown will automatically power down a system at a given time unless overridden by the local User or System Administrator.

7. Resident PCs should be connected to constant power sources, not switched power, and should never be powered down from the control system.

B. Controlled Devices:

1. Wherever possible, the Control System shall provide positive feedback of individual component control-state conditions to the touch panel. For example, the touch panel page to control a Blu-Ray/ DVD player shall have a status window indicating the status of the device (such as “Play Mode”) or the absence of media (such as “No Tape” or “No Disc”). If environmental controls are triggered with a particular device, the trigger for that environmental control should be feedback from the device rather than a simple button push. For example, if the control system is to automatically lower the lights when the player is placed in “Play” mode, the control system should not directly trigger the lighting preset from the “Play” button press, but rather by first confirming that a tape is present in the player and that the player is in fact in “Play” mode.

2. Each media playback device shall have its transport controls duplicated on the touch panel with a dedicated control page. The control functionality for each device shall closely mimic the control functions on the device itself. For example, a DVD or Blu-ray player shall have, at minimum, the five basic transport functions, play, stop, fast-forward, rewind, and pause. The Play and Stop buttons should be prominent. All transport buttons should change color when active.

3. For a DVD player or Blu-ray player, the programmer should provide the five basic transport functions plus chapter skip forward, chapter skip reverse, and where available, a button to access a subpage providing more advanced control. The advanced controls subpage should have buttons which would allow the user to navigate the menu structure of a DVD or Blu-ray disc and might also have, for example, buttons and tools to select subtitles and language tracks.

4. If a device can play multiple types of media and has bi-directional communication with the control system, the system shall read the media type and adjust the screen options as appropriate for the playback option selected. For example, a Blu-ray player which is able to play Blu-ray discs, DVDs, and CDs and has RS-232 control, the system shall display different options when a Blu-ray disc is detected by the unit versus when a DVD or CD is detected by the unit (such as the ability to route the signal to a display device versus just audio playback transport controls). In this example, “graying out” the inappropriate buttons for options is acceptable.

5. For a video projector or other display device with an automatic set-up, auto image adjust or similar button, control of this feature should be provided on every logical page, such as PC input pages.

6. Control the power to video projectors and other display devices separately from the rest of the AV system. Depending on the devices required for the initially selected “Room Mode”, Users should be able to operate audio only playback devices, or control lighting or room dimming systems without automatically powering on the displays. A ‘projector control’ or ‘display control’ button should be available at the main menu where a user can choose to power up or power down the display devices. Additionally, if the “Room Mode” selected by the User, such as video conferencing, is expected to require the use of the main display device(s) then it/they should be automatically powered on.

7. In rooms with a motorized projection screen, control of the motorized projection screen should be configured such that the screen is only deployed when the projectors are in

operation and should be set up to automatically deploy or retract when the projectors are powered on or off respectively.

## 3.9 EQUIPMENT RACK INSTALLATION

A. Supply completely assembled and fully shop-tested racks with all internal wiring completed as required to provide a complete system, to the extent that such items are not provided by others.

B. All power cables, low voltage control cables, and high level cables shall be run on the right side of an equipment rack as viewed from the rear. All other cables shall be run on the left side of an equipment as viewed from the rear.

C. When dressing the equipment rack, cable ties shall be placed at appropriate intervals of approximately six (6) inches for vertical bundles, four (4) inches for horizontal bundles. No cable ties shall cause the cable to exceed the manufacturer's recommended bend radius or deform the cable.

D. All vertical cable bundles internal to AV system equipment racks shall be attached to the rack frame utilizing a cable management system.

E. Use only Velcro-type cable straps to mount and bundle all cables. The use of plastic wire ties is prohibited. No exceptions.

F. All equipment racks shall by fully dressed out and cabled shall not protrude from the back of the rack.

G. All cable entry shall be through the tops of equipment racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear, or side panel openings.

H. Millwork installed or pivoting racks shall be provided with a sufficient amount of dressed cabling or harness to allow free and untethered travel of the rack from the permanent locking position to the extended "service" position.

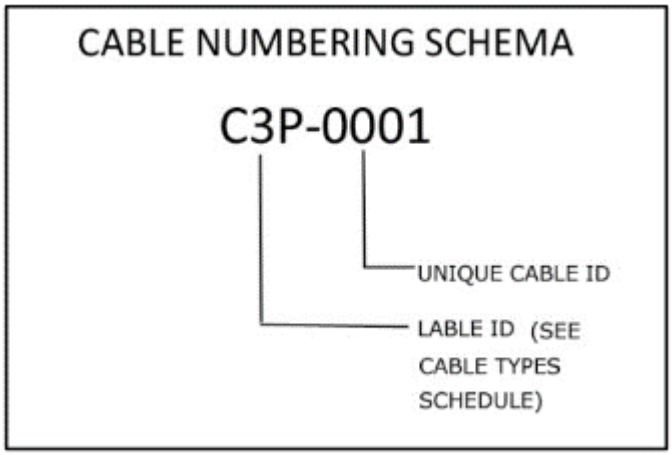
## 3.10 CABLE INSTALLATION

A. All cables for this project must conform to the latest version of NFPA 70 as well as local code requirements.

B. Where existing cabling is to be abandoned, it shall be completely removed as directed in the NFPA 70 / NFPA 72. No exceptions.

C. All cables, regardless of length, shall be marked with permanent wrap-around number letter cable markers at both ends. There shall be no unmarked cables at any place in the system. Wire labels done by hand in the field must be replaced with computer-generated labels for legibility. Marking codes used on cables shall match the codes / labels shown on the AVC shop drawings and on run sheets. The labeling scheme shall not follow any pre-existing cabling on the premises, but shall instead follow the method recommended within ANSI-AVIXA Standard F501.01-2015 "Cable Labeling for AV Systems", namely:

1. The primary data element consists of a mandatory unique identifier and optional prefix/suffix information, providing the basis for identification of the cable.
2. Each cable shall have a unique identifier that shall be in alphanumeric format and readable without the aid of a machine. This identifier is determined by the schema identified in the project documentation. The numbering system should contain a consistent number of digits.
3. This unique identifier (primary data element) shall be placed on the first/top row of the label closest to the connector or cut end of the cable. The primary data element may be duplicated on subsequent rows to aid in legibility.
4. Example of cable labeling scheme:




D. CAT6A / 4k cable runs shall not exceed the most current BICSI telecommunications cabling standards, i.e. 100 meters inclusive of all cross-connects, patches etcetera. When the distances are longer, the AVC must coordinate with the cable manufacturer to verify performance is still within the acceptable range of performance for this scope of work. No exceptions.

E. Internal and inter-rack cabling shall be neatly strapped, dressed, labeled, and adequately supported without pinching the cable bundle.

F. Use only Velcro-type cable straps to mount and bundle all cables. The use of plastic wire ties is prohibited. No exceptions.

G. Terminal blocks, boards, strips, or connectors shall be furnished for all cables that interface with racks, cabinets, consoles, or equipment modules. The use of “wire nuts” to terminate or connect cabling is strictly prohibited.

H. All cables and bundles shall be grouped according to the signals being carried. In order to reduce signal intermodulation distortion, separate groups shall be formed for the following cables:

1. Power loudspeaker cables
2. Low voltage system cables
3. Video cables / Category cables
4. Audio cables carrying signal levels less than -20.0 dBm

5. Audio cables carrying signal levels between -20.0 dBm and +20.0 dBm

6. Audio cables carrying signal levels greater than +20.0 dBm

I. All cables shall be continuous lengths without splices. All system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No bare wire terminations shall be allowed, unless specified on the drawings. No exceptions. Heat-shrink tubing shall be used to insulate the ground or drain wire.

J. All solder connections shall be made with rosin-core solder using temperature-controlled solder stations. No cold or cracked solder joints are acceptable. Any connections, which do not appear to be clean and shiny, or which show signs of cracking, shall be re-soldered by the AV Contractor before Final Acceptance testing of the system.

K. Mechanical connections using insulations, crimp-type connectors shall be bonded to the connector by soldering the wire to the metal part of the connector.

L. Connections made with screw actuated pressure type terminal strips shall be made by stripping approximately 1/4-inch of insulation from the stranded connector. The un-tinned wire shall be inserted into the terminal and tightened.

M. All wire bundles are to be neat and combed free of cable crossovers.

N. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.

O. All wire markers / labels shall face a common direction.

P. All cables shall have proper connector housing.

Q. All cables located in the ceiling areas, excluding corridors, where conduit as not been provided for are to be J-hooked and kept separate from data cables with crossovers at ninety (90) degrees. Large conduit sleeves shall be required for all inaccessible ceiling areas or hard lid ceilings.

R. All cable passing through penetrations in fire rated walls must be fire blocked after cable installation by the AV Contractor.

## 3.11 CLEAN-UP AND REPAIR

A. During the installation, the Contractor shall be expected to maintain a clean and safe working environment.

B. Upon completion of the work the Contractor shall remove all their refuse and rubbish from and about the premises and shall leave the relevant areas and equipment clean and in an operational state. The Contractor shall be responsible for repairing any damage caused to the premises by the AV Contractor's installation activities, at no cost to the Owner.

## 3.12 PROTECTION

A. Protect Work, stored products, and construction equipment from theft and vandalism.

B. Protect Owner's operations at site from theft, vandalism or damage from AV Contractor's work or employees.

C. Maintain security program throughout construction period, until Owner occupancy or Owner acceptance precludes the need for AV Contractor security.

## 3.13 FACTORY COMMISSIONING AND INSTALLATION ASSISTANCE

A. The Contractor shall engage a factory service representative to assist in the installation, configuration, and calibration of certain audio-video equipment. The factory service representative shall also be responsible for training the Owner’s technical personnel to adjust, operate, and maintain the equipment.

B. The following system(s) shall require factory representative commissioning and installation assistance:

1. Video production switcher and associated equipment
2. Audio mixer and associated equipment
3. Audio digital signal processor and associated equipment

C. Each factory representative (or group thereof) shall submit, prior to final acceptance testing, the following closeout materials in advance of their departure from the job site for review. Factory representatives shall not be dismissed from the job site until the submittals have been reviewed and approved by the Consultant.

1. Sound system or video system test/measurement reports equivalent to those required of the AVC above.
2. Any manuals, training materials, or maintenance materials provided.

## 3.14 SYSTEM TESTING AND COMMISSIONING

A. General:

1. Before Final Acceptance tests are scheduled, the Contractor shall perform a complete system checkout. The Contractor shall furnish all required test equipment and shall perform all work necessary to determine and/or modify performance of the system to meet the requirements of this specification.
2. For system components requiring special rigging procedures and onsite equipment installation, perform acceptance tests specific to those components prior to removal of onsite rigging/equipment. Examples of onsite rigging/equipment include, but is not limited to, scaffolding and platforms, manual/motorized lifts, hoists and winches, and cranes.
3. For any audio or video system tests performed which yield results indicating failure to meet the performance requirements of this specification, the Contractor shall be held responsible for all costs related to adjustments and aiming of components required to rectify the failed conditions.

4. Maintain onsite documentation of all field related changes / as-builts etcetera as well as performance tests for reference by the AV Consultant during the site surveys and Final Acceptance testing.
5. Adjust, balance, and align all equipment for optimum quality and to meet the manufacturer's published specifications. Establish and note normal settings for all device controls and record these settings in the Operation and Maintenance (O & M) Manual.
6. Check all low voltage control system functions and presets, from all controlling devices to all controlled devices, for proper operation.

B. Testing Equipment: The AV Contractor shall provide the following test equipment for use during their initial tests and adjustments and, if necessary, during Final Acceptance testing of the system by the AV Consultant.

1. Data Cable Analyzer: Hardware and software requirements include but are not limited to:
   a. Level III accuracy in accordance with ANSI/TIA-1152
   b. Permanent Link Adapters: RJ45 Adapter must meet requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C. Twisted pair Category 6A, 7 or 7A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
   c. Results Storage: Must be capable of storing and reporting results.
   d. Fluke DSX-602 or equivalent
2. True RMS Voltmeter: Measurements in decibels, linear to 100 kHz. Fluke 175 or equivalent
3. 250 MHz Dual Trace Oscilloscope: With external video trigger capabilities
4. Audio Analyzer: Hardware and software requirements include but are not limited to:
   a. Class 1 device which shall be calibrated in the field. Shall meet ANSI S1.4 specifications for Type I sound level meters.
   b. 1/12-octave real time FFT spectrum analyzer, with a minimum of six (6) curve integration averaging
   c. 1/12-octave band filter set meeting ANSI S1.11 specifications
   d. Audio signal test measurement set
   e. SPL functionality including dBA, dBB and dBC weighted scale functionality
   f. STI-PA software or discrete device where intelligibility is required as part of the project scope
   g. Larson Davis, Bruel & Kiae (B&K), NTi, or equivalent
5. Audio Signal Generator: Continuously variable from 20.0 Hz to 20.0 kHz within +1.00 dB with less than 0.50 percent THD. Include the ability to produce Pink and White noise, sine wave (variable frequency) and sweep generator, with variable output: -60.0 dB-V to +4.00 dBm
6. Distortion Analyzer: Tunable 1/12-octave band wave analyzer allowing readings down to 1.00 percent of the fundamental for measuring THD, hum amplitude and noise spectrum shape

7. AFMG SysTime V1.3.7 (or newer) as a loudspeaker cluster time alignment software tool
8. HDBT Video Analyzer: Quantum 280 Test Set (280A video analyzer & 280G video generator) or the Quantum Data 780 Category cable tester, or newer
9. HDMI device and pre-terminated cable tests: Murideo Fox & Hound 4k HDMI generator / analyzer set
10. Spectrophotometer: Calibration up to 5000 nits. X-Rite i1 Basic Pro 3 or equivalent
11. 4k HDMI Signal Generator: Marshall Electronics V-SG4K-HDI or equivalent
12. Professional Blue-Ray player (HDMI), with associated AV Blu-ray test discs at 4k resolution.
13. Computer Video Signals: Computer to have HDMI 2.0 (or most current standard) or DisplayPort++ where applicable. Utilize all video related test signals including:
    a. Run all “Picture Line-Up Generation Equipment” (PLUGE) testing including:
        1) SMPTE Color Bars
        2) Greyscale
    b. Moiré pattern to verify no key-stoning is used in the alignment of the projected image
    c. “H” pattern to verify no video signal distortion
    d. Motion video to verify no image tearing on sharp edges
14. Intel (OmniTek) Ultra 4k Tool Box for DisplayPort (4k / p60) & up to 12-SDI coaxial cable digital video stream
15. All field test instruments shall be within the calibration period recommended by the manufacturer.

C. Audio System Tests

1. General Audio System Tests:
    a. General Inspection and Adjustment: Measure and subsequentially document that all individual components are performing in accordance with each manufacturer’s published specifications. Specifically, examine frequency response, audible harmonic distortion, and signal-to-noise (S/N) ratio. Replace any components found to be defective.
    b. Freedom from Parasitic Oscillation and Radio-Frequency (RF) Pickup: Check to ensure that the system is free from spurious oscillation and radio-frequency pickup, both in the absence of any audio input signal and also when the system is driven to full output from 20.0 Hz to 20.0 kHz. Utilize a dual trace oscilloscope as specified.
    c. Loudspeaker Phasing: Perform phasing checks of loudspeaker lines by means of a DC source at one end of each line and a voltmeter at the other end. Phase all loudspeaker lines identically with respect to color coding.
    d. Freedom from Buzzes, Rattles and Objectionable Distortion: Apply a slow sine wave sweep from 20.0 Hz to 20.0 kHz at a level 6.00 dB below rated power amplifier output voltage. Listen carefully for buzzes, rattles, and objectionable distortion. Correct any causes of these defects, unless the cause is clearly outside the sound amplification system equipment and installation, in which case, the cause shall be brough to the attention of the AV Consultant.

e. Gain Control Settings: Establish tentative normal settings for all gain controls. All gain controls on rack-mounted equipment shall be adjusted for optimum S/N ratio and signal balance. Settings may require further adjustment by the AV Contractor as a result of testing by the AV Consultant. After final gain and attenuator settings have been established, mark all control settings with an adhesive indicator dot or arrow on the amplifiers.

f. Freedom from Switching Transient Noise: Operate all AC power sequencing equipment while listening for clicks and pops in the system outputs. Eliminate any found.

g. Initial Listening Test: Listen to normal program material to be sure that there are no remaining defects.

2. Loudspeaker Equalization Tests – 70.7 Volt Distributed Systems

a. Perform all tests and adjustments required to obtain specified performance. Tests and adjustments shall be performed when all ceiling tiles, acoustical treatment panels, sound screens, furnishings, etcetera are in their final position and ready for personnel. HVAC and lighting shall be operating at normal conditions.

b. Measure the ambient sound level in 1/12-octave bands with all HVAC systems and lights on. Record data as 1/3-octave band readings. Also measure and record the ambient sound level as a single wideband C-weighted (dBC) reading.

c. Individually test each loudspeaker circuit or zone extensively for uniform sound pressure levels (SPL) and adjust the system as necessary.

d. With the pink noise (or sweep generator) off and power amplifier on, and with all amplifier attenuation controls set at an 80.0% rotation (or +80.0 dB where applicable) in all areas, the system hum and noise must be inaudible. Any mechanical rattles or audio distortion must be corrected at this time.

e. Apply the pink noise or sweep generator signal to system and adjust for a working level for the equalization of the system of at least +20.0 dB above the ambient sound level. Staff must use ear protection.

f. Check for uniformity of coverage utilizing a 32-band, 1/12-octave Class 1 spectrum analyzer. The level in all areas must not deviate more than +/- 2.00 dBC. Correct any out of tolerance deviations before proceeding to the next zone / loudspeaker circuit.

g. Document all findings. Provide the AV Consultant “Before” and “After” spreadsheet and resultant frequency response curves and graphical test results for a representative quantity of each speaker type or zone. Note microphone test locations on floor-plan drawings.

3. Loudspeaker Equalization Tests – Low Impedance Loudspeaker Systems

a. Perform all tests and adjustments required to obtain specified performance. Tests and adjustments shall be performed when all ceiling tiles, acoustical treatment panels, sound screens, furnishings, etcetera are in their final position and ready for personnel. HVAC and lighting shall be operating at normal conditions.

b. Measure the ambient sound level in 1/12-octave bands with all HVAC systems and lights on. Record data as 1/3-octave band readings. Also measure and record the ambient sound level as a single wideband C-weighted (dBC) reading.

c. The DSP shall utilize the loudspeaker manufacturer's Finite Impulse Response (FIR) files as an initial starting point for equalization.

d. Using an AC impedance meter or bridge, measure all loudspeaker circuit's impedance at 1.00 kHz while disconnected from the amplifier output and note the data. This will assure that the speaker circuits are free of faults and will not overload the amplifier.

e. With the pink noise (or sweep generator) off and power amplifier on, and with all amplifier attenuation controls set at an 80.0% rotation (or +80.0 dB where applicable) in all areas, the system hum and noise must be inaudible. Any mechanical rattles or audio distortion must be corrected at this time.

f. Perform time domain alignment of full frequency loudspeaker and separated subwoofer units. It is recommended that the AVC coordinate with the loudspeaker manufacturer regarding this complex procedure.

   1) Utilize and record an impulse response sweep for both the full frequency loudspeakers and the subwoofers separately.

   2) Time align the full frequency loudspeaker's 1st peak with that on the subwoofer's 1st peak.

   3) Verify time alignment by testing various locations in the space and document microphone locations on floor-plan drawings that correspond to testing results.

   4) Consider using AFMG SysTime V1.3.7 (or newer) as an alignment software tool, or similar.

   5) It is understood that not all locations can be perfectly aligned but the AVC shall adjust the system for the best overall performance with the space under test.

g. Apply the pink noise or sweep generator signal to system and adjust for a working level for the equalization of the system of at least +20.0 dB above the ambient sound level. Hearing protection must be provided for all individuals present.

h. Check for uniformity of coverage utilizing a 32-band, 1/12-octave Class 1 spectrum analyzer. The level in all areas must not deviate more than +/- 2.00 dBC. Correct any out of tolerance deviations before proceeding.

i. System Ring-Out (Feedback Reduction): Once the sound system has been equalized to obtain a flat response, each microphone input (hardwired & wireless) shall ring out using the following procedure or similar. Hearing protection must be provided for all individuals present:

   1) Attach oscilloscope to the output of the sound system.

   2) Turn on one (1) microphone.

   3) Raise system volume until feedback begins.

   4) Use the oscilloscope to find the largest peak.

   5) Add a very narrow parametric filter to "notch" out that frequency on the corresponding microphone channel.

   6) Repeat feedback procedure to eliminate several feedback frequencies. When using wireless microphones, be sure to walk about the space to excite other potential feedback frequencies.

7) Once feedback has been essentially eliminated from the microphone, (in software) add a compression module or block with moderate compression ratio, attack and release settings. When the microphone is used the effect shall not be noticeable.

8) Verify that the compression algorithm has not altered the feedback suppression in place.

9) Test remaining microphone input(s) using the same general procedure.

j. Document all findings. Provide the AV Consultant "Before" and "After" spreadsheet and resultant frequency response curves and graphical test results for all low impedance full frequency range loudspeakers, sub-woofers and loudspeaker clusters, array devices etcetera.

4. Acoustical Tests

a. Make all necessary adjustments to ensure proper operation of the system. Tests and adjustments shall be performed when all ceiling tiles, acoustical treatment panels, sound screens, furnishings, etcetera are in their final position and ready for personnel. HVAC and lighting shall be operating at normal conditions.

b. Measure and document the conditions of the sound reinforcement system, including pre-existing and newly-installed equipment. The tests must be performed using a computer running a software-based audio analysis suite such as Smaart by Rational Acoustics, along with testing microphones, speakers, accessories as authorized/recommended by the software developer. All testing equipment must have been calibrated within the past 12 months at the time of use. The sound measurements will be conducted within the audience areas. The primary objective of these measurements is to determine the degree of uniformity in the audio coverage to the audience areas. The measurements will include the following:

1) Utilizing full frequency pink noise source fed into the existing sound reinforcement system, the loudspeaker systems' coverage extents will be measured with calibrated test equipment.

2) Calculate the Audio Coverage Uniformity in Listener Areas (ACU) using the industry-standard methodologies prescribed in ANSI/AVIXA A102.01:2022 at various locations within the room.

3) Calculate the sound system's production of Spectral Balance (SB) using the industry-standard methodologies prescribed in ANSI/AVIXA A103.01:2022 at various locations within the room.

4) Calculate the system's total harmonic distortion (THD).

5) Calculate the system's Speech Transmission Index (STI) and STIPA (STI for public address systems) using the industry-standard methodologies prescribed in IEC-602682-16:2020 (rev.5).

6) The overall space average acoustical frequency response within each area served shall be within the limits given by the AV Consultant within this specification. Test signals shall be broadband "pink" noise applied to any system input. Measurements shall be made using 1/12-octave band filters centered on ANSI preferred frequencies. Sweep tests can also be utilized.

7) Throughout the coverage area of the system, amplified sound levels shall not vary more than +/- 3.00 dB as measured using an octave band of "pink" noise centered at 4.00 kHz as the test signal.

8) Measurements of system performance shall be made using a calibrated ANSI S1.4, Type I sound level meter set for "slow" meter damping and flat response. The microphone shall be positioned 4.00 feet above the floor within the area served by the system. The system gain shall be set to provide octave band levels at least 10.0 dB above background noise levels in any octave band at the measuring locations for these tests.

9) Low Impedance Systems: Measurements shall be taken in a grid fashion at twenty (20) foot intervals in all directions. Provide a floor-plan map to add clarity that may be used during Final Acceptance Testing by the Consultant.

10) 70.7 Volt Systems: Measurements shall be taken on axis as well as at the point of overlapping speaker coverage.

11) Upon completion of above tests and any necessary adjustments, submit two (2) copies of a report presenting test results in graphical format with units clearly marked, including numerical values in a table where necessary, for review by the Consultant prior to Final Acceptance Testing, final tuning and demonstration. With With this report, submit certification that the installation conforms to the requirements stated herein, is complete in all respects, and is ready for inspection, testing and final tuning.

D. Balanced Twisted Pair Cable (Cat6, Cat6A or Similar) Testing

1. All outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to testing. Any testing performed on incomplete systems shall be redone upon completion of work.

2. Testing shall be performed on each cabling segment. Sampling is not acceptable

3. Test results submitted for balanced twisted pair cables shall be recorded by Fluke Linkware or approved format on CD and include but not be limited to the following:

a. Wire Map: Verify pin-to-pin termination at each end and check for installation connectivity errors. Document which connectivity color scheme is used at each location as defined in ANSI/TIA-568-C.2.

b. Cable Length: Report the length of each balanced twisted pair. The physical length of the link calculated using the pair with the shortest electrical delay shall be used for making the "Pass" or "Fail" determination.

c. Propagation Delay: Report the propagation delay of each balanced twisted pair and verify that it does not exceed 498 ns per ANSI/TIA-568.2-D when measured at 10 MHz per ANSI/TIA-1152-A.

d. Delay Skew: Report the delay skew and verify that it does not exceed 44 ns per ANSI/TIA-568.2-D.

e. Insertion Loss: Report worst case and worst margins in one direction for all four pairs.

f. Near-End Crosstalk (NEXT): Report worst case and worst margins in both directions for the all possible pair combinations:

g. Power-Sum Near-End Crosstalk (PS-NEXT): Report worst case and worst margins in both directions for all four pairs.

h. Attenuation Crosstalk Ratio Near-End (ACR-N): Report worst case and worst margins in both directions for all possible pair combinations:

i. Power-Sum Attenuation Crosstalk Ratio Near-End (PS-ACR-N): Report worst case and worst margins in both directions for all four pairs.

j. Attenuation Crosstalk Ratio Far-End (ACR-F): Report worst case and worst margins in both directions for all possible pair combinations:

k. Power-Sum Attenuation Crosstalk Ratio Far-End (PS-ACR-F): Report worst case and worst margins in both directions for all four pairs.

l. Return Loss: Report worst case and worst margins in both directions for all four pairs.

m. Provide Time Domain Xtalk Analyzer data.

n. Provide Time Domain Reflectometer data.

4. Testing of horizontal cabling shall not be performed on test equipment with marginal pass/fail notification disabled. If the tester is capable of indicating tests that pass with a measured value closer to the limit than the guaranteed accuracy of the tester, the test result shall be marked (typically as “Pass” or “Fail”).

5. Marginal pass results will not be accepted. Contractor shall correct issues and retest at no expense to the Owner.

E. General Video System Tests

1. General:

a. Check to determine that all projectors, projector bases, carts, tables, and mirrors are rigid and vibration-less in operation.

b. Test and record all optical projection images for average light level, light fall-off, image alignment, and size to comply with the manufacturer’s performance standards and specification drawings.

2. HDBT Distributed Video System Tests:

a. AVC shall test every possible routing of sources, matrix switching cross-points and end point sinks etcetera and document the results for future reference. This procedure shall take place after the initial category cable point-to-point testing.

b. The Contractor shall provide to the AV Consultant a copy of the following test results in electronic format in order to verify the AV video equipment has been installed and configured correctly:

1) The number of HDCP KDVs Keys supported by each source.

2) The video timing, HDCP use and audio format of each source when operating.

3) The video timings and supported audio formats for each connected sink.

4) The video timings and supported audio formats presented in the EDID to each source. The preferred video timing shall be indicated.

5) The length of cable used on all shielded twisted pair cable used for AV distribution.

6) The data rate supported by each twisted pair cable used for AV distribution per table below:

| *Video Format* | *Data Frame Rate (Gbps)* |
|---|---|
| 4320p (8k / 60 fps) + HDR[1] | 80.19 |
| 4320p (8k / 60 fps) | 64.15 |
| 2160p (4k / 60 fps) + HDR[1] | 20.05 |
| 2160p (4k / 60 fps) | 17.82 |
| UHD 3840 x 2160 (60 fps) | 11.9 |
| 1080p + HDR[1] | 5.57 |
| 1080p (60 fps) | 4.46 |
| 1600 x 1200 | 4.86 |
| 1920 x 1200 | 4.62 |
| 1080p | 4.44 |
| 1360 x 768 | 2.54 |
| 720p / 1080i | 2.22 |

c. Check that the image is correctly displayed on the video monitors and/or the video projector. Image must completely fill the imaging area and be “square” without the use of any type of “key-stoning” on video projection systems. No exceptions.

d. Test each input using crosshatch signal, checkerboard signal, Moiré and “H” pattern signals, color balance and greyscale / contrast etcetera at the scan rates indicated in items above.

e. Repeat tests at each connection location.

3. Blu-ray / Universal Format Player Tests:

a. Insert the pre-recorded 4k disc into the deck and check operation of the control panel’s transport controls as well as picture image quality. Also check that the audio signal is head from the left and right speakers, where applicable.

b. Check that the transport controls are logically presented on the touch screen GUI

c. Check that the audio and video signals are recorded and can be played back on the picture monitor(s) and/or the video projector and the left, right and surround loudspeakers etcetera, where applicable.

4. Network Distributed Video System Tests:

a. AVC shall test every possible routing of sources and end point sinks etcetera and document the results for future preference. This procedure shall take place after the initial category cable point-to-point testing as detailed above.

5. Video Coaxial Distributed Digital Cable System Tests:

a. AVC shall test and verify all gain losses as documented in the Shop Drawing submittals. Any endpoint that requires additional gain or attenuation shall be in compliance with the signal strength the sink device requires.

F. Bluetooth Device Tests

1. Document which Bluetooth Standard Profiles are being used in the project: A2DP, HFP, HSP etcetera.
2. Document the release version of Bluetooth being used, i.e. 5.2 or newer.
3. Provide a discrete name for all Bluetooth receivers via manufacturer's software.
4. Verify each receiver's ability to perform pairing.
5. Document connectivity range to verify it is within manufacturer's specifications.
6. Document names, test results, and software package used.

G. Assistive Listening System (ALS) Tests

1. Verify that the entire scope area to be covered by the ALS provides clear audible sound with no discernable distortion.

## 3.15 DEMONSTRATION AND FINAL ACCEPTANCE TESTING

A. General:

1. Final Acceptance Testing shall not be performed until the AV Contractor's system checkout has been completed, documented, and results submitted to the AV Consultant for approval.
2. Upon approval of the AVC test reports by the AV Consultant, and at a time established by the Consultant, demonstrate the operation of each major component of the system and the completed installation. Typically ten (10) working days after the AVC test documentation / As-Built Drawings have been submitted for approval.

B. Site Testing: To be conducted in the presence of the Architect / Construction Manager / Owner (or representative) and the AV Consultant and shall consist of the following:

1. Final As-Built Drawings, run sheets, O & M Manuals, submitted test results, and other required documents, as detailed in the Construction Documents shall be on hand. One (1) complete set of these documents shall be delivered to the Owner at this time (one complete set shall have been delivered to the Architect prior to the scheduling of Final Acceptance Testing in PDF format).
2. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
3. The AVC shall demonstrate the operation of all system equipment installed.
4. Both subjective and objective tests shall be required by the AV Consultant to determine compliance with the specifications. The AVC shall be responsible for providing test equipment for this exercise. Therefore, be prepared to repeat and verify test results previously submitted to the AV Consultant. It is anticipated that final loudspeaker tuning / equalization adjustments shall be made at the direction of the AV Consultant.

C. After demonstration, assist as required in the following acceptance tests:

1. Listening tests: These tests may include speech intelligibility survey and subjective aural evaluations by observers at various positions under various operating conditions, using live speech and/or recorded music material.
2. Equipment tests: Any measurements of frequency response, distortion, noise or other characteristics and any operational tests deemed necessary may be performed on any item or group of items to determine conformity with these requirements.

D. Control System Operation: AVC shall coordinate with the Owner to review the operation of the AV system prior to and during installation. During the second training session, the Owner can request additional changes and updates to the GUI and system functionality if they so choose without additional cost to the project.

E. If the need for adjustment or modification becomes fully evident during demonstration and testing, continue working until the installation operates fully in accordance with the requirement of this specification.

F. In the event significant adjustments are required during the Final Acceptance Testing phase, or defective equipment must be repaired or replaces, tests may be suspended or continued at the option of the AV Consultant, Architect, and/or the Owner. The AVC can and shall be responsible for the AV Consultant's expenses such as, but not limited to, lodging, travel, airfare, the AV Consultant's billable time etcetera.

## 3.16 DOCUMENTATION

A. Project Record: The AV Contractor shall supply one (1) clean full-size print of the system drawings which show all changes which were made during fabrication and installation to the Architect / Owner.

B. Maintenance Information:

1. The AV Contractor shall provide technical information for all electronic apparatuses, including but not limited to schematic diagrams and parts lists, manufacturer's installation instructions, operating instructions, and technical specifications.
2. The AV Contractor submittal shall include all shop drawings prepared and used by the AVC, as well as those which were not required to be submitted for approval. This shall include, but not be limited to, wiring diagrams, schedules for identification of building wiring and installation details useful to a maintenance technician.

C. Operation and Maintenance (O & M) Manuals: Provide one (1) hard copy of an instruction manual to the Owner containing the following:

1. Table of Contents
2. Bill of Materials
3. Instructions for operating the system in all modes of operation and for fulfilling all functional requirements.
4. List of settings and adjustments for semi-fixes controls.
5. Manufacturer's sheets of specifications, operating instructions, and service information arranged alphabetically by manufacturer and then by model number.

6. Detailed wiring diagrams and the simplified one-line diagram.
7. All system and device software files, executable, GUI etcetera.

D. Quick Reference Guide Manuals:

1. AVC shall provide the Owner with four (4) copies of laminated "Quick-Reference Guide Manuals" detailing the operation of each standalone AV system.
2. This Manual shall include both touch-panel layouts and general system "how-to" quick-references.
3. This guide should be not less than two (2) pages where both sides of a standard letter sized sheet are used. If multiple pages are included in the Manual, then in addition to being laminated, the pages shall be bound together in a spiral or ring-type binder, complete with rigid cover and back protectors, and a prominent cover label.

## 3.17 DEMONSTRATION

A. A minimum of sixteen (16) hours of training shall be provided by the AV Contractor, at dates and times decided and finally accepted by the Owner, within a mutually agreed upon set of date/time choices established between the Owner and AV Contractor. Refer to Division 01 Section 01700 "Contract Closeout" article "Field Instruction" for additional requirements.

1. Contractor must break the training sessions into a minimum of four (4) sessions (each lasting no more than 4 hours) and a maximum of five (5) sessions (each lasting no more than 4 hours). The sessions must address the following requirements.
2. All sessions must occur after the completion of all system startup, commissioning, testing/tuning and punchlist back-checking efforts are completed.
3. An initial set of two (2) to three (3) sessions must occur prior to final acceptance and turnover to Owner, broken into at least two (2) separate calendar days during normal business hours. At the conclusion of the second-to-last of these sessions (and prior to the final one of these initial sessions): The AVC shall administer a Competency Quiz/Exercise to all staff who have been trained. The purpose of the Competency Quiz/Exercise shall be to ensure that there was a level of knowledge & skill obtained from the initial training.
4. At least one (1) week after the initial training sessions mentioned above, the Contractor shall return and conduct one (1) final session of not less than four (4) hours in length. The Contractor shall again review the Competency Quiz/Exercise questions with Owner attendees. Additionally, the Contractor shall walk through all components and functions of the entire system. The Contractor shall present the As-Built drawings, O&M manuals, and a Quick-Reference Guide Manual and familiarize the Owner attendees with these documents. This will allow the Owner to acquaint themselves with the system so that they can provide follow up questions as to the systems operation.

B. During the training, the participants shall be given opportunities for "hands-on" experience with operating the controls. There shall be visual and audible demonstrations using the systems themselves as aids. Personnel for instruction and training for the AV systems shall be designated by the Owner.

C. In the event the AVC does not have qualified instructors on staff for projects with sophisticated or complex equipment, the Contractor will provide a manufacturer's representative for such instruction at no additional cost to the Owner.

D. Training and instruction shall be provided in the presence of the AV Consultant. This condition may be waived at the discretion of the Consultant.

E. Training sessions must be video-recorded by the Contractor and delivered in duplicate (2) copies on portable, external USB 3.2 flash drives with USB-C connector; "Sandisk Extreme Portable SSD" series (500 GB minimum storage capacity). Contractor will supply the equipment necessary to record all training sessions. Contractor shall provide a reasonable amount of post-editing of said video recordings after the training sessions to: crop any unnecessary segments; perform audio track compression (so that the audio is all within a reasonable dynamic range without too many extreme soft or extreme loud segments); perform audio track normalization (to set the mean audio level to a reasonably-loud setting; and to render the recording to high-quality yet reasonably-small video container files without excessive file compression artifacts. After performing post-editing and rendering of the training video file(s), the Contractor shall provide two (2) electronic copies to the Owner (contained on Qty.2 USB flash drives) to the Owner.

**END OF SECTION**

# SECTION 27 4100.10 – AUDIO VIDEO SYSTEMS FOR TEST KITCHEN AND RECORDING SUITE

## PART 1 GENERAL

### 1.1 SUMMARY

A. Section includes a subset of the Audio-Video Systems for the NMSU New Mexico Department of Agriculture Office Building project – in particular, the systems and locations described as follows. Refer to "Systems Descriptions" articles farther below for additional information.

1. Test Kitchen 139 & Conference Room 138
2. Recording 136

B. All requirements listed in Division 27 section 27 41 00 "Common Work Results for Audio-Video Systems" shall apply to this section.

### 1.2 RELATED DOCUMENTS

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

B. Division 26 Electrical Sections pertaining to basic materials and installation methods, raceways, boxes, supports, grounding and bonding, and wiring.

C. Division 27 Telecommunication Sections pertaining to structured UTP/STP cabling, fiber optic cabling, low voltage coaxial signal distribution and installation methods.

D. Section 27 4100 COMMON WORK RESULTS FOR AUDIO VIDEO SYSTEMS for general requirements, as well as a list of other Related Documents.

E. Audio-Video Systems (XA-series) Drawings for equipment locations, system layouts, one-line diagrams, and details.

### 1.3 SYSTEMS DESCRIPTIONS – BASE BID:

A. Test Kitchen & Conference Room:

1. The test kitchen will feature live cooking demonstrations and be designed to comfortably fit audiences of up to 100 people when combined with contiguously-adjacent Conference Room area. It will support live, recorded, and streamed demonstrations, and a partial-coverage tubular pipe grid system located immediately above the test kitchen work area will support the rigging of the audio, video, and lighting equipment.
2. The conference room is contiguously-adjacent to the Test Kitchen, and will be able to transition seamlessly from overflow seating area test kitchen demonstrations to a meeting and presentation area. The audio infrastructure will be designed to cater to diverse room

configurations, with a mix of wireless and wired audio solutions to ensure clear sound quality for presenters and attendees alike. It will also be equipped with a large laser projector and motorized roll-down screen for presentations, and robotic PTZ cameras tailored for video teleconferencing.

3. When the room seating is facing North for Test Kitchen demonstrations, the wall will remain open and audiences will be able to watch from further back and view close-ups of cooking shots on the portable displays, with a live audio feed coming through the overhead speakers. When the room is oriented south, the wall will be closed and audience seating will face a large flat-panel display and camera for teleconferencing, in-person meetings, and presentations

4. Audio System: Microphones will be able to be mixed by a technician remotely from the console in the control room or wirelessly with an iPad/tablet app-based virtual mixer. Presets for different system configurations will allow user-friendly adjustments of sub-mixes for in-person audiences, streaming audiences, and archival recordings.

    a. Microphones: Presenters will be wear body-worn wireless mic transmitters and “lavalier-style” microphones or handheld microphones depending on the nature of their presentation. Audio will be supplemented with mic feeds from directional “shotgun” style microphones positioned in the overhead pipe grid as well as 2 area mics on kitchen counters to capture ambient cooking sounds. Additionally, a portable camera-mounted shotgun microphone will allow flexible capture of audio by the in-person shoulder-worn camera operator.

    b. Speakers: Two overhead speakers will be installed in the accessible ceiling above the audience area to deliver audio for any test kitchen audiences. There will also be two weather-rated speakers mounted to the walls on the outdoor patio area directly outside of the test kitchen, which will be a possible overflow seating area.

5. Video System:

    a. Cameras: To get the best views of various phases of food preparation in real-time, high-res cameras installed “on set” will provide technicians/producers multiple options to select from for various audience streams. The setup features:

        1) a fixed overhead camera for wide shots of the kitchen island work surface

        2) two remotely controllable pan-tilt-zoom (PTZ) cameras on a pipe grid for dynamic angles

        3) a wide-shot camera affixed to the ceiling for general views, and

        4) a mobile unit for additional flexibility, with distributed RJ45 VoIP video ports throughout the space to minimize cabling frustrations

        5) in the conference area: 2 wall- and ceiling- mounted remote-controllable PTZ cameras with intelligent speaker tracking capabilities for teleconferencing.

    b. Displays: The test kitchen will utilize ceiling-mounted flat-panel video display panels facing the audience area, as well as two sets of twin “back-to-back” monitors farther back in the audience area. These twin “back-to-back” monitors will provide flexible use for the test kitchen presenters, conference presenters, and audiences (facing either direction).

    c. Media sharing: There will be HDMI inputs for content from guest sources (laptops, etc) at the lectern, with HDMI ports hidden in floor boxes distributed across the room

(3 in-floor boxes), as well as Wireless screensharing (Extron ShareLink 250W or Crestron AirMedia) capabilities.

6. Rack-Mounted Items (in Control Room):
   a. Video “presentation” signal switcher
   b. Production video/camera switcher
   c. Recording/streaming deck
   d. Video AV-over-IP encoders and decoders
   e. Wireless microphone antenna distributor
   f. Wireless microphone receivers
   g. Audio DSP
   h. Control system processor
   i. 10-gig “AV LAN” ethernet network switch
   j. Uninterruptible power supply (UPS)
   k. Rack-mounted light
7. Counter-Mounted Items (in Control Room):
   a. Audio mixing console
   b. Video production console
   c. Camera joystick controller
   d. Camera control unit (CCU) interface
   e. LCD computer monitors
   f. Owner-Furnished computers (each with monitor and keyboard/mouse):
      1) One for Live/post-production & editing.
      2) One for software management of audio mixer, video production mixer, etc.
      3) One for character generation and teleprompter feed.

B. Recording:
   1. TBD.

## 1.4 SYSTEMS DESCRIPTIONS – ADD/ALTERNATE(S):

A. TBD.

## PART 2 PRODUCTS

## 2.1 EQUIPMENT LIST

A. Unless otherwise indicated, equipment in this Section shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. All components used in the system shall be commercial designs that comply with the Specifications.

## PART 3 EXECUTION

### 3.1 SPECIFIC REQUIREMENTS

A. TBD.

**REFER TO APPENDIX(ES) ON FOLLOWING PAGES.**

**SECTION 27 4100.20 – 27 4100 20-Audio-Visual Systems For Conference Rooms and other spaces**

## 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 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, testing, and labeling of all telecommunications infrastructure as described on the Drawings and/or required by these specifications.

B. Furnishing equipment, cabling, supplies, and materials

C. Furnishing labor for installation, testing, software programming, and user training.

D. Third-party testing and commissioning

E. Service and maintenance contract

F. All other operations that are not explicitly described herein but are necessary for a complete functioning system shall adhere to the performance parameters as described on the drawings and/or required by these specifications.

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

1. Division 26, Section 26 0500, “Common Work Results for Electrical”: Power supply, conduit and wiring.
2. Division 27, Section 27 0500, Common Work Results for Communications.
3. Division 27, Section 27 1622, Cabling for Audio-Visual Systems.
4. Division 27, Section 27 4181, Audio-Visual Control Systems.

### 1.3 REFERENCES

A. Underwriters Laboratories Inc. (UL)

B. International Code Council (ICC):

C. International Building Code, Latest Edition adopted by State of New Mexico Commercial Building Code.

D. AVIXA CTS Manual

E. National Electrical Code, Latest Edition

## 1.4 DEFINITIONS

A. Terms:

1. Bidder: Entity generating the bid response.
2. Contractor: Successful Bidder to whom the Owner has awarded the contract.
3. Installer (a.k.a. “Audiovisual Systems Integrator” or similar): Actual entity providing the audiovisual systems installation. Generally equivalent to “Contractor” or else a sub-contractor hired by the Contractor.
4. Furnish: Indicates the responsibility to ship or deliver the item to the job site, freight prepaid, for receipt, staging and installation by others.
5. Install or Installation: Indicates the responsibility of receiving the item at the job site, providing adequate storage, unpacking or uncrating the item, physically securing the item or otherwise making ready the item for its intended use by following the instructions and approved methods of the manufacturer and those contained herein.
6. Provide: Indicates the responsibility to both “Furnish” and “Install.”
7. Installation Materials: Shall refer to installed materials which may or may not be explicitly specified herein, but which are essential to a complete functioning system such as the following:
    a. Concealed cabling, exposed and/or loose cabling, cable terminations, cable adapters, cable management, cable labeling, cable dressing, and patch cords (voice, data, audio and/or video)
    b. Custom connection panels and/or blank cover panels for rough-in devices (wall boxes, floor boxes, ceiling boxes, cubbies) or rack-mounted termination/patch fields
8. NIC or Not In Contract: Equivalent to “Provided by Others”.
9. OFCI or Owner Furnished Contractor Installed: Shall refer to equipment that will be furnished by the Owner for installation by the Contractor. The Contractor shall be responsible for installing and integrating this equipment as detailed herein.
10. The term “shall” is mandatory; the term “will” is informative; and the term “should” is advisory.
11. Format or Aspect Ratio: Proportion of image area expressed as a ratio of width/height.
    a. 16:9 or “HD” or “HDTV” Wide Format: 2.35
    b. 16:10 or “Computer” Wide Format: 1.85.1.
    c. 4:3 or NTSC, SD or SDTV Legacy Video Format 1.33.1

B. Acronyms:

1. ADA: Americans with Disabilities Act
2. ALS: Assistive Listening System intended for persons with hearing disabilities

3. AV: Audio-Video or Audio-Visual
4. BGM: Background Music
5. CATV: Community Access Television (aka “cable television”)
6. CPU: Central Processing Unit
7. DANTE AUDIO: Replaces analog audio equipment and cabling with a computer network
8. DSP: Digital Signal Processor mainly used for audio
9. DVD: Digital Video Disc or Digital Versátiles Disc. This acronym refers to the standard optical disc format for playback of audiovisual and/or multi-media.
10. BLU-RAY: BLU-RAY is a digital optical disc storage format. It is designed to supersede the DVD format, and capable of storing several hours of high-definition video.
11. FPD: Flat Panel Display
12. LCD: Liquid Crystal Display, a type of flat panel display
13. LED: Light Emitting Diode display a type of flat panel display
14. OLED: OLED’s Pixels produce their own light on a pixel by pixel basis a type of flat panel display.
15. NanoCell: NanoCell offers better image quality and dynamic range than other LED TVs with bright, vivid, accurate colors. A type of flat panel display.
16. LASER PROJECTOR: The main visual benefit of laser projection is that laser light sources offer better color accuracy – often called a wider color gamut. In addition to the colors themselves, laser projectors offer better brightness uniformity and lower brightness decline over the lifetime of the projector.
17. BULB PROJECTOR: The Projector Lamp, otherwise known as the a projector bulb, is a replaceable part of the projector that needs to be maintained according to the lamp life of the projector, which averages between 1,000 and 2,000 hours
18. TV: Television
19. MATV: Master Antenna Television distribution system
20. RF: Radio Frequency
21. IR: Infrared sometimes called infrared light, is used as a control protocol for controlling AV equipment.
22. RS 232: RS232 stands for "Recommended Standard 232" and it is a type of serial communication used for controlling devices that accept RS 232. This is a 2 way communication protocol
23. IP: Internet Protocol
24. IT: Information Technology
25. LAN: Local Area Network
26. WAN: Wide Area Network.
27. PC: Personal Computer. This acronym applies to stationary “tower” or “desktop” workstations, in addition to portable “notebook” or “laptop” computers.

28. Streaming: Streaming is a method of viewing video content without actually downloading the media files.

29. UPS: Uninterruptible Power Supply.

30. USB: Universal Serial Bus, a serial bus standard to interface data devices.

31. Media Player hardware or software to play media content

## 1.5 SYSTEM NARRATIVE

A. This system will be used for streaming and recording live performances, meetings, sporting events, and other types of AV production.

B. Director #105 and #107 – A/V System Type "A": shall employ a built-in multi-media system consisting of: A large format wall mounted display connected to a wall mounted HDMI pass through wall plate with audio enhancement deployed via a video conference sound bar.

1. A wall mounted Contractor Furnished Contractor Installed Flat Panel Display with tilting mount. The Aspect Ratio of the Flat Panel Display shall conform to the 16:9 or "UHD" or "UHDTV" Wide Format as defined herein.

2. Inputs for audio visual signal types shall be provided from an input connection module located in a Contractor Furnished wall plate module mounted above counter below the flat panel display. Transport of video and audio signals between the modules shall be via HDMI cable. Inputs at the wall plate shall include HDMI w/embedded audio. Inputs behind the display shall include HDMI w/embedded audio.

3. Program audio sound reinforcement shall be via video conference sound bar.

4. Control of the flat panel display shall be via the factory remote control.

C. Conference #108, #112B, and #115E– A/V System Type "B": The Conference room shall employ a built-in multi-media system consisting of:

1. A wall mounted Contractor Furnished Contractor Installed Flat Panel Display with tilting mount. The Aspect Ratio of the Flat Panel Display shall conform to the 16:9 or "UHD" or "UHDTV" Wide Format as defined herein.

2. Inputs for various audio-visual signal types shall be provided on wall plate style input connection panels located in a floor box under the conference table. Inputs shall include HDMI w/embedded audio.

3. Program audio sound reinforcement shall be via a conference sound bar located below the flat panel display.

4. The sound bar shall employ a web cam, microphone and speakers

5. A wireless presentation system shall be provided for wireless transmission of presentation material from laptops, tablets, and smart phones directly to the flat panel display.

6. Control of the flat panel display shall be via bi-directional RS-232 serial and/or Ethernet.

7. A Push-button Control Panel to provide system control shall be provided in a slanted enclosure on the top surface of the conference table. The control panel shall feature an integrated A/V control processor such that it is capable of issuing the actual device control commands via Ethernet. The control panel shall be connected to a control port expansion

module via Ethernet, which shall serve to translate the device control commands from Ethernet to RS-232. The Contractor shall provide all configuration and programming of the control panel and expansion module to provide a fully functioning system. Refer to Section 274181 – Audio-Visual Control Systems for programming requirements. System control shall include (at a minimum):

a. Source selection – HDMI 1, HDMI 2, and Wireless Presentation Receiver. All source selection buttons shall be clearly labeled.

b. A/V system and flat panel display power – ON/OFF.

c. Image mute/Blank video toggle.

d. Volume and mute control with visual feedback.

e. A connection via Ethernet from the control processor to the Owner's network for centralized device administration.

8. This system shall also integrate with the owner vendor simulation system. Coordinate with owner vendor for required integration requirements.

D. Conference #113– A/V System Type "C": The Conference room shall employ a built-in multi-media system consisting of:

1. Dual wall mounted Contractor Furnished Contractor Installed Flat Panel Display with tilting mount. The Aspect Ratio of the Flat Panel Display shall conform to the 16:9 or "UHD" or "UHDTV" Wide Format as defined herein.

2. Inputs for various audio-visual signal types shall be provided on wall plate style input connection panels located in a floor box under the conference table. Inputs shall include HDMI w/embedded audio.

3. Program audio sound reinforcement shall be via a ceiling speakers

4. Speech enhancement shall be via a table-top conferencing microphone.

5. A wall mounted PTZ style web cam mounted above the displays shall be used to provide video conferencing capabilities to the space.

6. A wireless presentation system shall be provided for wireless transmission of presentation material from laptops, tablets, and smart phones directly to the flat panel display.

7. Control of the flat panel display shall be via bi-directional RS-232 serial and/or Ethernet.

8. A Push-button Control Panel to provide system control shall be provided in a slanted enclosure on the top surface of the conference table. The control panel shall feature an integrated A/V control processor such that it is capable of issuing the actual device control commands via Ethernet. The control panel shall be connected to a control port expansion module via Ethernet, which shall serve to translate the device control commands from Ethernet to RS-232. The Contractor shall provide all configuration and programming of the control panel and expansion module to provide a fully functioning system. Refer to Section 274181 – Audio-Visual Control Systems for programming requirements. System control shall include (at a minimum):

a. Source selection – HDMI 1, HDMI 2, and Wireless Presentation Receiver. All source selection buttons shall be clearly labeled.

b. A/V system and flat panel display power – ON/OFF.

c. Image mute/Blank video toggle.

d. Volume and mute control with visual feedback.

e. A connection via Ethernet from the control processor to the Owner's network for centralized device administration.

9. This system shall also integrate with the owner vendor simulation system. Coordinate with owner vendor for required integration requirements.

E. Lobby #101– A/V System Type "D": The Lobby room shall employ a built-in multi-media system consisting of: Large-format flat panel LCD video/graphics monitors to function as public user interfaces and educational tools for display of public announcements, way-finding information, mass notification messaging, and branding/advertising.

## 1.6 DESIGN PRINCIPLES

A. Flexibility: The facility's cable pathway infrastructure (utilized for audiovisual signals, as well as relevant data/voice and AC power signals) shall be sufficiently flexible to allow future expansion of the audiovisual systems. Design parameters for such expansion are in accordance with the Owner's long-term goals and expectations for such systems, as outlined within this section. There will be a 5 foot service loop at the projector, and a 5 foot service for all other cables. The service loop shall be located coiled above the ceiling near the destinations connector.

B. The service loop for the racks will be coiled above the ceiling. The service loops for other equipment will be coiled above the ceiling.

C. Cost Effectiveness: The AV systems shall utilize limited resources with utmost efficiency. Emphasis lies on common usability and current technology standards, and not on emerging technology trends or enhanced features.

D. Ease of Operation: The AV systems shall require a minimal amount of Owner training for successful operation. User interfaces (control panels, signal connection panels, etc.) shall have a consistent look and feel throughout the facility.

E. Sustainability: The AV systems shall be designed with a high degree of reliability in mind. Operation of such systems shall require minimal ongoing maintenance, as well as minimal investment by the Owner in dedicated support personnel. It is recommended that the Owner establish an agreement with the AV systems integrator, to secure warranty service calls and/or ongoing maintenance support.

F. Network Connectivity: With the convergence of audiovisual and information technologies, careful planning must occur to ensure that network connectivity is provided for IP-enabled audiovisual devices and systems. Telecommunications outlets and their port quantities must be coordinated to meet or exceed the requirements of the appropriate audiovisual equipment. Discussion with the Owner's IT staff/entity will be required to ensure proper coordination between the audiovisual systems and the network design.

G. Each network device that has a static IP shall be labeled on the front and the rear with the units IP address, Subnet, Login information (Login and Password)

H. If the device is using DHCP the assigned information for that piece should be reserved in the DHCP server. IP Address, subnet, logon password if any should be labeled on the front and the rear of that device.

I. Button control systems will have its labels laser engraved.

J. Hook and loop Velcro will be used on all cable pulls that are bundled or secured to a rack.

1. Cables of the same color will be bundled together. These bundles will be kept separated in the racks, furniture ext.

2. Cables that are attached to cable trays will be bundled in the same colors. If the cable tray is being used for IT cabling the AV cables will be bundled and secured to J-hooks along the bottom of the cable trays.

3. The use of cable ties shall be held to the bare minimum..

## 1.7 PERFORMANCE REQUIREMENTS

A. All Audiovisual Systems shall interface and be compatible with each other.

B. Audio

C. Analog

1. Polarity: Absolute signal polarity will be maintained throughout the signal chain such that a positive signal at the input produces a corresponding positive excursion at the loudspeakers.

2. Electronics: The audio system electronics shall deliver the following minimum performance standards as measured from all source inputs for microphones, disc and/or cassette playback devices, etc., through all mixers, audio distribution amplifiers, routers, etc., to all audio signal destinations.

a. Frequency Response: +/- 0.5dB, 20-20,000 Hz

b. Hum and Noise: -70 dBu, 20-20,000 Hz, un-weighted

c. Distortion: 0.1% THD, 20-20,000 Hz

3. Speech Signal: The system shall provide a speech signal in the audience seating area that meets the following requirements:

a. Frequency response within +/- 3 dB from 500 Hz to 15,000 Hz.

b. Overall SPL variance of +/- 3 db.

c. Measured percentage articulation loss of consonants (Alcons) of 10% or lower.

d. Maximum average SPL of 90 dB (flat), with 10 dB of undistorted headroom available.

4. Digital audio

5. Optical

a. Digital audio is a technology that is used to record, store, manipulate, generate and reproduce sound using audio signals that have been encoded in digital form. It also

refers to the sequence of discreet samples that are taken from an analog audio waveform.

6. Dante

   a. The Dante/MTX/MRX network will not join with an existing local area network or include some other network devices (however, the control network for applications such as MTX-MRX Editor or Wireless DCP can be used together with the Dante network).

   b. Integrator will not be using multicast flows (only relevant if you are using Dante Controller).

D. C- Network switch

1. A non-blocking layer-2/3 gigabit switches w- POE & PoE+
2. All the ports are capable of simultaneous gigabit transfer (whether the switch is non-blocking), determine whether the switching capacity is at least 1 GBPS × the number of ports × 2 (for in and out).
3. Capable of switching off Energy Efficient Ethernet (EEE) and other power-saving features
4. We recommend managed (intelligent) switches that can be configured and monitored.
5. We recommend switches that support DiffServ (DSCP) Quality of Service (QoS) with strict
6. We recommend unmanaged 1 GB network switches for control.
   a. Category cable shall be terminated using the TIA 528 B standard.
   b. Shielded Category 6A will be used for all Digital Video runs.
   c. 360 degree shielded Cat 6A RJ 45 connectors will be used all shielded category cable.
   d. There will be no more than 3 interconnect points.
   e. Where possible direct runs are preferred
   f. Video Category 6A shielded cabling will have a yellow jacket. This is used for video sources.
   g. Control Non Shielded Category 6A will have a green jacket. This is used for system control lines, Network switch for control.
   h. Non Shielded Category 6A will have a orange jacket. This is used for Misc. connections i.e. Touch panels, USB extenders, and like items.
   i. Shielded Category 6A is used for Dante audio will have a black jacket
   j. Premade category cable of the correct color are recommended for interconnects in the rack.
   k. Premade cables will be used to interface the touch panel, USB Extenders or any other product that gets moved around its assigned area. These cables must allow the customer to move the device up to 8'. Excess cable will be coiled and strapped with Velcro one wrap tape.
   l. Cables will be bundled in their color in the rack.

m. Velcro hook and loop tape should be used to bundle all the Category cables. Wire ties are not a Cables of the same color or function will be dressed in separate bundles in the rack. i.e. Yellow with yellow, orange with orange, And green with green.

n. All cabling will be dressed in the rack to make it easier to identify what the color is used for.

o. Cabling in the rack must have a service loop so equipment can be removed from the rack without having to disconnect the equipment.

p. If there is no interconnect panel and the cables are coming thru a feed thru wall plate than a 10' Whip will be used to allow the end user to move the rack or podium.

q. This whip should be covered with a black general purpose braided cable sleeve. It is the contractor's choice to use a full braid or a wraparound material.

r. Cable Labels will be 6" back from that cables connector

E. Product Samples (upon request):

1. Cabling and connectors – typical for each type
2. Cable marking samples: As described in Section 27 1622.
3. Equipment labels
4. Connection panel / faceplate with etched engraving
5. Equipment rack identification panel – refer to paragraph (F) below.

F. Field quality-control test reports: For speech and program audio amplification systems identified herein to ensure proper speech intelligibility, gain-before-feedback, loudness and coverage uniformity under typical operating circumstances.

1. Class 2 Sound Level Meter, 30-130DBA Range SPL Meter, Max/Min Data Hold, A/C Mode, LCD Back Light, Portable. Measure ambient noise levels with all normal systems operating (HVAC, lighting, etc) and with all components of sound reinforcement system powered on without any amplified signal.
2. Measured electrical impedance for all loudspeaker channels. 4,6,8 or 16 ohm
3. Plots of system Reverberation Time (RT) measurements.
4. Plots of system Sound Pressure Level (SPL) histograms.

G. Equipment Rack Identification Panel:

1. Within each room containing equipment racks for audio-visual systems, a custom graphical identification shall be installed within one (1) of the equipment's rack(s) in that room. All audio-visual racks in the facility shall be identical aside for information specific to the associated room or system type.
2. Submit graphical layout of this panel to the owner or consultant for review using a common digital image format such as JPEG, GIF, TIFF or bitmap.
3. The panel design should include the following as a minimum- NO EXCEPTIONS
   a. Integrators name and contact information
   b. Design Consultants name

c. Owners name and a brief description / identifier of the project or system type.

d. One Red RJ 45 for Cat 5E for system programming.

## 1.8 SUBMITTALS

A. Product Data: For all proposed equipment, cables and connectors, and faceplates for evaluation of technical features. Reference each product to a location on Drawings. Include the following:

1. Manufacturer's submittal sheet (if applicable).
2. Manufacturer's published specification "cut" sheets.
3. Operating characteristics, furnished specialties, and accessories.
4. Physical data (dimensions, weight, line art and/or photos).
5. Test and evaluation data (frequency and phase plots at on-axis and multiple off-axis incidence angles, impedance plot, 1/3-octave polar coverage patterns, etc.)

B. Shop Drawings: The shop drawings listed below are required of the Contractor. Submit all Shop Drawings complete as a single submission. Isolated items will not be accepted, except with prior approval.

1. System Narrative: Concise narrative description of the system's performance capabilities, physical connection topology, and sequence of operation for each different "scene" or "mode".
2. Wiring Schematic / Connection Diagram: Detailed wiring diagrams showing interconnection of components and products, wiring and cabling diagrams depicting cable types and designators, and device designators. Provide connector designations and terminal strip identification, along with color codes for cables connecting to these devices. Give each component a unique designator and use this designator consistently throughout the project.
3. Diagrams for cable management system – e.g., inside equipment racks, in cable tray, etc.
4. Cabling Schedule: A list containing the cable type, cable marker identifier, and origination and destination location and connector types for each cable.
5. Mounting Details for Loudspeakers: Scaled drawings of complete mounting details, hardware and support surfaces, including details on all load requirements, safety factors, and structural materials.
6. Panels: Scaled drawings of interconnect panels.
7. Equipment & Panel Labels: A list containing the identifier label for all panels and rack mounted equipment. Include information on label type and construction.
8. Equipment Rack Layouts: Fully detailed rack drawings (rack front elevations) indicating equipment orientation within the equipment rack.
9. Cable Routing / Riser Diagram: Diagram showing conduits/pathways for audio and control cabling with clear indications of which cables will be installed in each pathway. Cabling installed in each pathway may be called out via tags on the diagram or via cable run schedule(s) included with the diagram. All cable runs shall be identified with cable ID tags which match those shown on the connection diagram/signal flow diagram described above.

10. Consultant's floor plan and enlarged plan project document sheets in electronic format are available to be supplied to the Contractor (upon formal request) for their use as part of submittals. Consultant's detail and diagram sheets in electronic format shall not be provided to the Contractor. Shop drawing submittals containing information copied directly from the Consultant's document sheets without addition of proposed installation or configuration information shall be rejected.

## 1.9 QUALITY ASSURANCE

A. Installer Qualifications: As part of the Bid Response, the Contractor shall furnish evidence of his/her qualifications to perform the work specified. Evidence of Contractor qualifications shall include the following:

1. The Bidder's installation team members shall include at least one
2. (1) Crestron Digital Media Installer DMC-I) and shall be on site
3. The Bidder's software programmer(s) shall hold a valid credential of "Crestron Certified Master Programmer" as licensed by the Crestron Technical Institute (CTI).
4. The Bidder shall clearly identify project team members (Installers) pertaining to the installation of AV systems.
5. Team members to be identified shall be Principal, Project Manager, Chief Engineer, Senior Field Technician, and Software Programmer.
6. The documentation shall include the individual's certification
7. Due to the complexity of the control & automation system, a manufacturer-certified software programmer shall be required to author the programming component of this project.
8. The Contractor shall include in the Bid Response, the name and office location of the manufacturer certified person or entity that will provide programming for the remote control system. Copies of the programmer's certification shall be included in the bid.
9. A list of equipment manufacturer product lines, relevant to the project, for which the Contractor is authorized as a Distributor, Dealer, and Installer.
10. A list of equipment manufacturer product lines, relevant to the project, for which the Contractor is authorized to provide warranty repair service.

B. All provided Installer and Programmer Qualifications (listed above) shall be current and valid at the time of bidding. For example, the Contractor shall not list a product manufacturer or line for which he/she is not a dealer on the bid due date, but for which he/she hopes or intends to become a dealer in the future.

C. Source Limitations: Obtain common materials and equipment through one source from a single manufacturer as much as practical.

D. All equipment for this installation shall be new (packaged in the manufacturer's original packaging), less than one year from the date of manufacture, and without blemish or defect.

E. The Contractor shall maintain the same project manager and field supervisor throughout the installation, and will maintain the same installers.

F. The Contractor shall supply and install any incidental equipment needed in order to result in a complete and operable system without claim for additional payment, even if such equipment is not listed in this Specification.

G. All work related to this Specification shall be completed in a professional manner by fully qualified workers.

H. Reliability: The systems shall be designed to provide professional quality operation over a period of several years without the need for continual maintenance. Equipment that has a high failure rate is not acceptable for installation as part of these systems.

I. Pre-installation meeting: Conduct pre-installation meeting with other trades to:

1. Verify project requirements and manufacturers' instructions
2. Coordinate environmental conditioning of the space (temperature & humidity)
3. Coordinate elements attaching to, penetrating through, or concealed above/behind work in this section.

J. 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.

K. Comply with NFPA 70, "National Electrical Code."

## 1.10 DELIVERY, STORAGE, AND HANDLING

A. Equipment, Cabling and Installation Materials:

1. Costs of all shipping to the site, and of all unusual storage requirements, shall be borne by the Contractor.
2. It shall be the responsibility of the Contractor to make appropriate arrangements, and to coordinate with the authorized personnel at the site, for the proper acceptance, handling, protections, and storage of equipment so delivered.
3. If containers are used open each container; verify contents against packing list, and file copy of packing list, complete with container identification for inclusion in operation and maintenance data.
4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.
5. Save all packing slips.
6. Waste Management and Disposal: Separate waste materials for recycling in accordance with Division 01, Section "Construction Waste Management and Disposal".
    a. Remove packaging materials from site and dispose of at appropriate recycling facilities.
    b. Collect and separate for disposal paper, plastic, corrugated cardboard and/or polystyrene packaging materials in appropriate onsite bins for recycling.

c. Dispose of all non-recyclable packaging materials and debris in a safe and environmentally responsible manner according to the instructions set forth by the General Contractor, local ordinances or codes and the Environmental Protection Agency.

## 1.11 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

B. Interior, Controlled Environment: System components installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F (2 to 50 deg C) and 20 to 90 percent relative humidity.

## 1.12 WARRANTY

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

B. Manufacturer Warranties: Submit to Owner or Owner's Representative all written and dated warranties, in addition to completed product support registration cards, as issued by product manufacturers warranting all individual components against defects in materials or manufacturing, for the periods established by said manufacturers. The start date of the warranties shall be the date of shipment from the manufacture.

1. A report shall be made that lists Manufacture, model number, serial number, date purchased and the manufactures warranty time.

C. System Warranty: The Bidding Contractor or sub-contractor (Installer) shall make known, in writing, at time of Bid any exceptions that might exist between conditions described herein and Installer's policy of warranty. After acceptance of bid, all conditions and requirements of warranty described herein shall apply.

1. For material that cares less than a 1 year warranty shall be documented by the contractor and that document included in the close out documents for the owner and designer.

D. Equipment that the Installer does not provide as part of this contract is exempt from this warranty coverage. However, the installation labor and materials associated with any equipment installed by the Installer, including OFCI items, shall be covered under this warranty.

E. During the warranty period, within 24 hours of notification, the Installer shall answer all service calls and requests for information.

F. During the warranty period, within 72 hours of original notification, the Installer shall provide emergency service to restore operation of the system, replacing defective materials, repairing faulty workmanship, making temporary repairs, and providing loaner equipment as necessary, all at no charge.

G. The Installer shall notify the Owner of any service call or work to be performed for which charges may be incurred before such work commences. The Owner may be billed for non-warranty calls.

H. Improper functioning, for warranty purposes, means failure of the system to meet the intentions of the specification because of internal defects.

I. It does not include Owner-caused malfunctions such as re-adjustment of the controls, re-tuning of the system, or injury to the system beyond normal wear.

J. Nor does the warranty cover paint, exterior finishes, fuses, lamps (including projection lamps) or associated labor, unless the damage or failure results from defective materials or workmanship covered by the warranty.

K. The Installer shall take such actions at the time of installation to ensure that all equipment is installed in accordance with the manufacturer recommended environmental and electrical operating conditions and requirements.

L. After installation, the Installer shall be responsible for the repair or replacement of said equipment that the Installer provided which fails due to environmental or electrical conditions, even if not covered by the manufacturer's warranty.

M. The Installer shall not be held responsible for damages due to changes in environmental conditions which occur after system acceptance.

N. If the Installer has modified certain components, the manufacturer's warranty for such components may become void. In such a case, the Installer is responsible for providing warranty coverage equal to that originally provided by the manufacturer.

O. Certain subsystems and system components may require installation by authorized representatives in order for the complete manufacturer warranty to apply. If this pertains to any subsystem or component for this project, it is the Installer's responsibility to make arrangements for the complete manufacturer warranty to apply. These arrangements are to be made at no additional cost to the Owner.

## 1.13 SERVICE CONTRACT

A. As part of this Specification, the Contractor shall initiate a one-year service contract to commence on the date of final acceptance and continue to the first anniversary of the date of final acceptance as defined in 'System Acceptance'. The scope of the service contract would normally extend beyond warranty service calls, to include ongoing support of the AV systems such as maintenance, periodic replacement of consumables, Owner training or assistance, and/or additional design-build agreements.

B. As part of the Bid Response, the Contractor shall provide the Owner with a proposal for continuation of the service contract to include Year Two (2), Year Three (3), Year Four (4) and Year Five (5) of operation. All terms and conditions of the Year One Warranty shall apply.

## 1.14 PRIOR APPROVAL

A. For substitutions of products specified herein, Contractor shall submit requests for prior approval at least 10 days prior to submitting bids, and in accordance with the provisions of Bidding Instructions and/or Division 1.

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. Provide products quantities as required. If a quantity is given, provide at least the given amount.

B. Products shall be new, free from defects and listed by UL when an applicable UL Standard exists. Provide Products of a given type from one manufacturer.

C. Regardless of the length or completeness of the descriptive paragraph under article titled “Manufacturers and Products”, provide Products complying with the specified manufacturer's published specifications.

D. Take care during installation to prevent scratches, dents, chips, etc.

### 2.2 MANUFACTURERS AND PRODUCTS

A. Refer to Appendix A, attached at the end of this document for manufacture and product requirements.

B. If a specified product has been discontinued by a manufacturer, and cannot be repaired by the manufacture during the warranty period. Than the contractor need to provide a replacement model (as certified by the manufacturer) Than any price difference should be discussed with the owner and once approved can be billed back to the owner

C. Where required provide manufacturer’s rack mount adapter or one manufactured by Middle Atlantic or other rack accessories manufacture.

D. Provide complete and fully functional systems, including items that are not explicitly described herein, but are necessary for a complete functioning system which shall adhere to the performance parameters as described on the drawings and/or required by these specifications. Items shall include, but are not limited to, all required mounting hardware and faceplates.

### 2.3 SOFTWARE

A. All commercial software used, shall be registered to Owner, in Owner’s name. Owner to be supplied with all software documentation including copies of software registration.

B. Contractor shall load and test the required software on an Owner furnished computer and load and test all required updates to control panels. Provide a complete and fully functional network management system.

C. Contractor shall provide all non-compiled programs including all macros, custom drivers as well as the compiled software on a flash drive (USB Stick). This includes controller, Touch panel, DSP’s and other items that require programming.

D. Coordinate all management, control and monitoring functions with the Owner. Minimum requirements shall include:

1. Event scheduling
2. System control of individual systems

## 2.4 MULTI-MEDIA SYSTEMS

A. Provide product makes and models as listed in APPENDIX A attached to the end of this Section.

1. Provide complete and fully functional systems, including items that are not explicitly described herein, but are necessary for a complete functioning system which shall adhere to the performance parameters as described on the drawings and/or required by these specifications. Items shall include, but are not limited to, all required mounting hardware and faceplates.

## 2.5 CABLING

A. Color code for Category 6A will be shielded yellow. This will be used for all digital video equipment

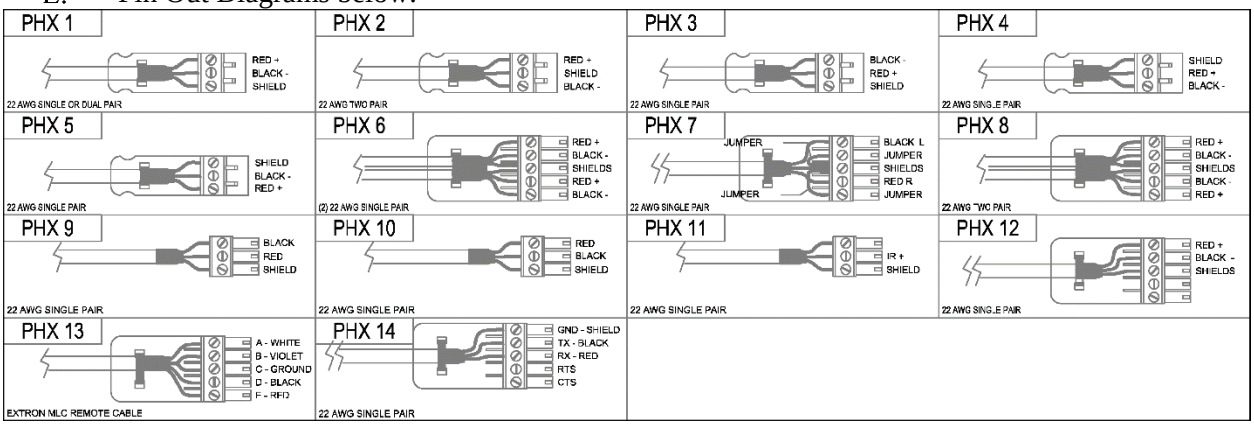
1. Green non shielded Category 6 or 6A will be used for all control of the system
2. Orange shielded Category 6 or 6A will be used for misc. equipment i.e. usb extenders, etc.
3. Black shielded Cat 6/6A for Dante and digital audio.

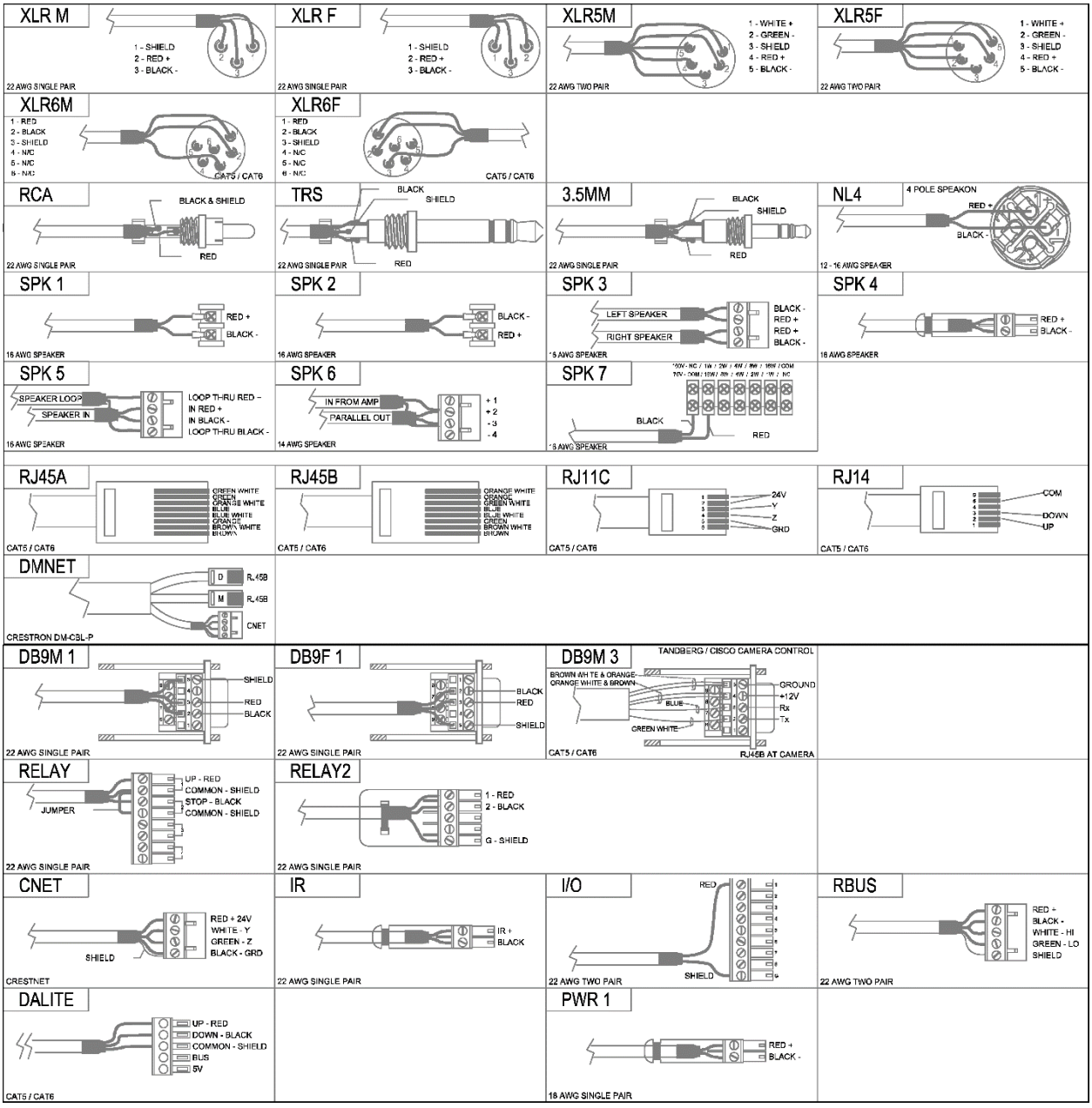
B. Any Category Cabling that does not go to a wall plates or items such as the Touch Panel, interconnect cabling will be flexible so as not to kink knot up.

C. Pre made cabling is recommended for internal rack work & connection for touch panel, usb, and other outboard equipment at the discretion of the contractor

D. Connection for touch panels shall terminate on a Red RJ 45 in a single input biscuit box.

E. Pin Out Diagrams below:






## 2.6 PRODUCT SUBSTITUTIONS

A. Refer to “Prior Approval” in Part 1 of this document.

B. The materials and products specified herein reflect the minimum acceptable standards of fabrication and manufacture. All materials and products supplied by the Contractor and specified herein are to be new, unused, of first quality and in original packaging or shipping containers or as shown on drawings.

C. The products listed herein are pre-approved for this project. Substitutions shall be permitted for the manufacturers and products contained herein, provided they equal or exceed the specifications thereof and are approved via formal request.

## 2.7 SURGE PROTECTION AND POWER

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.
3. Refer to the NEC handbook article 380 as it refers to power strips (Multiple output)

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to AV equipment, PCs, speakers, microphones and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Cable labeling will be 6” back from cables connector.

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

## 3.2 PREPARATION

A. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

B. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

## 3.3 GENERAL INSTALLATION PRACTICES

A. All equipment with the exception of portable equipment shall be firmly fastened or attached in place. A safety factor of at least four shall be utilized for all brackets, fasteners and attachments.

B. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.

C. The Contractor shall insure that all equipment is installed such that proper cooling and ventilation is insured.

D. All equipment shall be installed in a manner, which prevents hum, RF/EMI/EMF interference, and mechanical vibration based noises (e.g. fan mounts, etc.)

E. All equipment and furniture shall be protected from construction dust and debris until final acceptance of the system.

F. All equipment shall be protected from theft until final acceptance of the system.

G. The Contractor shall be under obligation to protect completed work and uncompleted work against damage or loss until the Owner has given final acceptance. Should the need arise to repair work or replace items. The Contractor shall do so at no cost to the Owner.

## 3.4 FURNITURE

A. The Contractor shall ensure that equipment or mounting hardware is compatible with and suitable for installation in furniture specified by the Architect, Consultant, or Furniture Supplier. It shall further be the Contractor's responsibility to ensure that such coordination with the Architect, Consultant, or Furniture Supplier occurs. The Contractor shall exchange with and follow such Shop Drawings as to ensure that dimensions and structural supports are adequate for the installation of specified equipment. It is the Contractor's responsibility that the request and delivery of such critical coordination information is satisfactorily executed. Inasmuch as the Contractor has control over the delivery of such information, he shall deliver it as requested by the Architect, Consultant, or Furniture Supplier.

## 3.5 EQUIPMENT RACKS AND CABLE MANAGEMENT

A. Use tamper-resistant Torx security type mounting screws for all rack-mounted A/V equipment. The owner will receive 3 additional Torx blades top allow the owner to have the ability to remove equipment.

B. Racks shall be installed in such a way so as to permit access to all equipment for service.

C. All equipment in racks shall be fitted with vent panels and/or fans as required to provide ventilation and cooling according to equipment manufacturer's recommendations. Fans should be ultra-quiet and able to move 120 CFM, have a noise level of no more than 24 DB and dual ball bearings. Fan guards will be used if the fan has an open front or rear for safety.

1. The fan can be AC or USB powered. It will have a thermostat to set the temperature of the rack-furniture..

2. Blank rack spaces will have a blank panel put in.

3. If possible a 2 RU locking drawer shall be used for holding mics, remotes for the equipment and other items that are used for video presentations.

D. Adjacent racks shall be bolted together with appropriate ganging hardware.

E. As a general practice, all power cables, control cables, and high-level cables shall be dressed to the left rear of an equipment rack. Audio and video cables shall be dressed to the right rear of the rack. Audio, video and control cables shall be bundled separately and spaced not less than three (3) inches apart.

F. Internal equipment rack cabling shall be supported by lacing strips, support brackets, or other cable management systems as required to ensure that all cabling is supported in both the vertical and horizontal planes within the rack.

G. With the exception of ganged equipment rack assemblies, cabling routed between equipment racks or pieces of equipment exterior to equipment racks, or extending to the greater facility cabling infrastructure, shall be completely protected, end-to-end, by a raceway, wire-way, or duct appropriately sized for the cable run.

H. Cabling between rolling pieces of equipment not housed in rack cabinets or a rolling equipment rack and any device to which it is connected, shall be protected by a split-loom corrugated tubing wrap or other such flexible cable management system appropriately sized for the cable run.

I. Any controls not to be adjusted by the user and accessible from the front of the equipment rack must be furnished with security panels.

J. 1 RU Rack shelves or specific rack mounts specific to that piece of equipment should be used to hold accessory equipment such as power supplies, extenders converters etc. No equipment should be attached or stacked on another piece of rack mounted equipment.

K. UL Listing: Rack system shall be UL Listed in the US and Canada.

## 3.6 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

## 3.7 IDENTIFICATION

A. All equipment components shall be identified with a unique, permanently affixed laser-engraved label. Provide a schedule or database of labels and identifiers to Owner at completion of project installation.

B. Information on the label will be where the cable connects to I.E HDMI DA (Output Number) and where it terminates. (DMPS-4k-350 (Input Number)

C. The label material will be printed on high adhesion self-laminating vinyl wire wraps.

D. Labels are applied 6” from the connector on the source and destination side of the cable.

E. At completion, all labels and schedules shall reflect as-built conditions.

F. All pieces that have a IP address associated with it will have a printed label on the front and back with that IP address.

## 3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Where required by equipment manufacturer, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. System Set-up and Tuning

1. Optimization: The Contractor shall install, configure, adjust, program, and calibrate all components in order to optimize the performance of all individual subsystems and the system as a whole.

C. Preliminary Tests:

1. General: Once the system is installed, the Contractor shall complete the following preliminary tests and prepare a written test report for the Consultant. The test report will list the results of each of the tests described in this section and certify that the installation is complete.

2. Control: Upon completion of installation, the Contractor shall test each function of each control station, push-button panel, touch screen panel, computer control interface, and all components connected to or interfaced to the Control System to verify proper operation and that each switch and indicator operates as intended.

3. Audio: The Contractor shall perform the following tests:

a. Prior to the termination of audio amplifiers to speakers, the Contractor shall measure the resistance of the speaker line with reference to ground to determine that no short circuits or paths to ground exist in the line. The Contractor shall connect the speaker to the cable and measure the impedance of each speaker line using a 1,000Hz signal applied to the line. The Contractor shall submit a list, to the Consultant, by cable number, of the impedance of each speaker line. This test shall be performed with the amplifier disconnected from the speaker line and the speaker connected to the speaker line.

b. Verify all loudspeakers are functioning.

c. Verify that the system meets all Performance Requirements as outlined in this section.

d. Verify that all equipment, panels, and cables are labeled correctly.

e. Verify each item of equipment is functioning as intended.

f. Verify the installation is the same as specified.

D. Video: To establish that the facility cabling and terminations meet the specifications necessary for proper functioning of the overall system, a video test signal shall be applied to each input cable and passed through the system switching and distribution networks with the results measured at each system output.

1. In addition, the Contractor shall:

a. Verify each item of equipment is functioning as intended.

b. Verify the installation is the same as specified.

2. Computer Video Display Devices: The Contractor shall use a computer-video test generator to establish that computer video capable displays such as LCD, flat panel, and projection devices are in good working order and optimally adjusted. The computer-video test generator shall be capable of outputting test signals on HDMI and VGA connectors. The computer-video test generator shall meet or exceed the following specifications and offer the following test patterns:

3. Analog Specifications:

a. Bandwidth: 450 MHz (VGA)

b. Dot clock: 230 MHz

c. Pixel clock accuracy: 0.02 MHz

d. Scan rate accuracy: +/- 2%

e. Frequency range: 15kHz to 127 kHz

f. Rise/fall time: < 1.2nS

g. Signal types: RGBHV

h. Maximum level: 1V p-p

i. Impedance: 75 ohms

j. Return loss: -30db @ 5MHz

k. DC offset: +/- 5mV maximum

l. Digital Specifications:

m. Ability to generate 1080P, 1080I, 720P, 2 K , 4K

n. Color Spaces: RGB, YCbCr (4:4:4, 4:2:2, 4:2:0)

o. Color Depth: 8-bit through 16-bit

p. HDMI Standard: HDMI 2.0. 2.2 (a)

q. Content Protection Standards: HDCP (1.4, 2.2)

r. EDID Information

s. Audio-

t. 4 independent audio channels (2 stereo pairs) each with adjustable level and frequency

u. Preset frequency selections 50/100/200/250/400/800 HZ,

v. 1,2,4,8,16 Khz

w. Audio sweep test 20khz to 20 Hz

E. Digital Test Generator:

1. The portable HDMI Signal Generator & Analyzer provides a convenient way to test and verify all aspects of an HDMI signal path, including source and sink. This unit complies with the HDMI 2.0a and HDCP 1.4/2.2 standards. The unit's Analyzer mode complies with the CEA standard HDR static metadata extensions CEA-861-F and CEA-861.3 for EDID analysis. Battery operation is recommended. Output resolutions should SDTV to 8K.

2. Test Patterns:

a. Pal-NTSC Color Bars

b. SMPTE Color Bars Used to Evaluate and adjust color decoder on the display. This also has the plunge pattern

c. Full Field Red

d. Full Field Green

e. Full Field Blue

f. Full Field Back

g. Full Field White

h. 8 Step Gray Scale

i. 16 Step Gray Scale Used to evaluate and adjust gray scale tracking If some are missing check the displays white, black level and gamma.

j. Vertical Split Used to measure contrast ratio, luminance of white

k. White Screen This pattern can be used for screen uniformity, peak luminance or white

l. Crosshatch,

m. Multiburst Vertical This is a resolution test to adjust sharpness and scaling capabilities of display

n. Moving Ball used to judge motion.

o. Alternate W.B. This pattern alternates between full field white than black. Used to test or analyze the backlight of an LCD Panel

p. Line V Scroll Used to check motion. The line should move across the screen smoothly and not choppy

q. Line H Scroll Used to check motion. The line should move across the screen smoothly and not choppy

r. Final Tests

s. Upon approval of the Contractor's test report, and at a time that is mutually acceptable to the Contractor, Owner and Consultant, the Contractor shall assist the Consultant and Owner in final system tests and adjustments. The Contractor shall allow one (1) day to perform the tests. The Contractor's representatives assisting in

the performance of these tests shall be thoroughly familiar with the details of the system and shall include the field supervisor responsible for installing the system.

t. To demonstrate the good working order of all playback devices in the system the Contractor shall make available high quality source materials for all audio and video media types represented in the system. To demonstrate the good working order of all computer-video displays the Contractor shall make available the computer-video signal generator described in 'Performance Standards – Preliminary Tests and Submittals – Computer Video Display Devices'. In addition, the Contractor shall make available a laptop computer with the ability to output:

3. Standard Definition television (SDTV)
   a. 480I (NTSC Composite)
   b. 576i (PAL compatible)
4. Enhanced definition television (EDTV)
   a. 480 P (720 X 480 progressive scan)
   b. 576P (720 X 576 progressive scan)
5. High Definition Television (HDTV)
   a. 720 P (1280 X 720 progressive Scan)
   b. 1080i (1920 X 1080)
   c. 1080P (1920 X 1280 progressive scan)
   d. 1366 X 768 HD
6. Ultra High definition television
   a. 2K (1920 X 1080P progressive scan)
   b. 4K UHD (3840 X 2160 Progressive scan)
   c. 8K UHD (7680 X 4320 progressive scan)

F. Graphics with at least 16bit color depth. The computer shall be capable of displaying spreadsheets, graphs, charts, pictures and text of varying sizes and fonts to effectively demonstrate the systems computer display imaging capabilities.

G. The Contractor shall demonstrate operation of all subsystems, including audio and video recording, displays, cameras, camera controls, streaming, and control system and so on, meets or exceeds the criteria as outlined in this section.

H. Remove and replace malfunctioning devices and circuits and retest as specified above.

## 3.9 STARTUP SERVICE

A. Engage a factory-authorized service representative as needed, to supervise and assist with startup service as needed. Complete installation and startup checks according to approved procedures and with manufacturer's written instructions.

## 3.10 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the AV components that have been powered up shall be locked and secured, with an activated access-control system or keyed system during periods when a qualified operator in the employ of Contractor is not present.

## 3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain AV system. Refer to Division 01 Section "Demonstration and Training."

B. The Contractor shall provide a total of four (4) hours of on-site training for the Owner's staff at a time that is mutually agreeable for the Owner and Contractor. The Contractor should anticipate three sessions of the following lengths: two (2) "basic" sessions of one hour each, and one (1) "advanced" session of two hours. The Owner may choose to have the sessions spread out over a maximum of three different days. Final acceptance and/or final payment for the system shall not be delayed due to scheduling delays beyond the control of the Contractor.

C. In addition, the Contractor is responsible for scheduling and coordinating the specified manufacturer training with the Owner.

## 3.12 SYSTEM ACCEPTANCE

A. Upon successful completion of Final Tests, Documentation and Training, the Contractor shall notify the Owner, in writing, that the system is complete. The Owner shall have twenty-one (21) days to generate a "punch list" of omissions, adjustments, corrections and the like and respond in writing to the Contractor. In the absence of such a "Punch List," the system shall be considered to be complete. The warranty shall commence on the twenty-first day after the Contractor's notification of completion of work, and the Owner shall process final payment. In the event that further work is required to complete this project, the Contractor shall be prepared to continue work, without additional compensation, until the system is accepted.

**END OF SECTION**

APPENDIX A - TBD

# SECTION 27 5119.11 - SOUND MASKING SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Networked sound-masking system.
2. Non-networked sound-masking system.
3. Wire and cable.

B. Related Requirements:

1. Section 095123 "Acoustical Tile Ceilings."
2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, enclosures, and cabinets serving communications systems.
3. Division 28 "Addressable Fire-Alarm Systems" for mute sound masking in the event of a fire emergency.

### 1.2 REFERENCES

A. ANSI S1.4, "Specification for Sound Level Meters."

B. ANSI S1.6, "Preferred Frequencies and Filter Band Center Frequencies for Acoustical Measurements."

C. ANSI S1.11, "Octave-Band and Fractional-Octave-Band Analog and Digital Filters."

D. ANSI 709.1, "Control Network Protocol Specification" for standards related to open platforms.

E. ASTM E1374-06, "Standard Guide for Open Office Acoustics and Applicable ASTM Standards."

F. ASTM E1573-18, "Standard Test Method for Measurement and Reporting of Masking Sound Levels Using A-Weighted and One-Third-Octave-Band Sound Pressure Levels."

G. NFPA 72, "National Fire Alarm and Signaling Code."

H. UL 1310, "Standard for Class 2 Power Units."

I. UL 1480, "Standard for Speakers for Fire Alarm and Signaling Systems, Including Accessories."

J. UL 2043, "Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces."

K. UL 2572, "Standard for Mass Notification Systems."

L. UL 60065, "Standard for Audio, Video and Similar Electronic Apparatus - Safety Requirements."

M. UL 6500, "Standard for Audio/Video and Musical Instrument Apparatus for Household, Commercial, and Similar General Use."

## 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions, profiles and finishes of individual components.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Nationally recognized testing laboratory listing data for plenum-mounted and rack-mounted equipment.

B. Shop Drawings: For sound-masking systems.

1. Include plans, elevations, sections, and mounting details for all system components. Provide schematics of system design including floor plan indicating quantity, type, and location of components.
2. Include details of equipment assemblies and installation instructions. 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.

## 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide as-built drawings of the system including schematics and floor plans indicating quantity, type, and location of components, cabling, and accessories.
2. Operation and maintenance manuals.
3. Provide warranty documentation, with start date(s) and service contract(s).

B. Software and Firmware Operational Documentation:

1. Inventory of system components, with model and serial numbers for each.
2. Software operating and upgrade manuals.
3. Program Software and System Settings Backup: On digital media complete with data files. Provide electronic backup file of all system settings.
4. Device address list.

5. Printout of software application and graphic screens.
6. Provide login ID and password(s) to access control functions on the graphical user interface, if applicable.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: Factory qualified and certified to install products listed.

1. Responsible for system specified and single contact point for Architect, Consultant, Fire Protection Engineer, and/or Owner with respect to sound-masking work specified.
2. Experienced in design, fabrication, installation, checkout, and warranty contract management of sound-masking systems.

B. Obtain required permits.

C. Follow applicable codes, including regulatory testing and certifications.

D. Equipment and associated hardware fabricated and installed in accordance with manufacturer's instructions.

E. Configuration and commissioning by an authorized manufacturer representative or their approved agent.

## 1.6 COORDINATION

A. Coordinate quantity and arrangement of sound-masking system components with ceiling space configuration and with components occupying ceiling space, including structural members, pipes, air-distribution components, raceways, cable trays, luminaires, and other items.

B. Coordinate raceway system material, routing and locations with Division 26 Contractor and General Contractor

## 1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver in manufacturer's original unopened and undamaged packages with manufacturer's labels legible and intact.

B. Store and handle in strict compliance with manufacturer's written instructions and recommendations. Protect from moisture during shipping, storage, and handling.

C. Inspect manufacturer's packages upon receipt.

### 1.8 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace sound-masking loudspeaker control units and loudspeakers that fail in materials, workmanship, or performance within one year (warranty period) from date of installation.

1. At Closeout, provide to Owner an executed copy of manufacturer's standard limited warranty against manufacturing defects, outlining terms, conditions, and exclusions from coverage.

B. System components for sound masking must carry a minimum 10-year warranty. Warranty statements must be submitted prior to notice to proceed.

1. Warranty Period: Ten years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Source Limitations: Obtain components for sound-masking system from a single source.

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

C. Compliance Standard: Fabricate and label electronic components to comply with UL 60065 or UL 1419.

D. Compliance Standard: Fabricate and label components to comply with UL 2572, in order to interface with a Fire Alarm Control Unit (FACU).

E. Wire, cable, devices, and assemblies installed in air-handling spaces to be plenum rated, complying with NFPA 70 requirements for rate of heat-release and smoke-release characteristics. Tests for these requirements to be in accordance with UL 2043.

### 2.2 NETWORKED SOUND-MASKING SYSTEMS

A. Description: Networked decentralized architecture **sound**-masking system with digital control of addressable system devices. Digital network controls at control panel include adjustments and monitoring and display of current settings for sound-masking and paging of loudspeaker controls, associated network devices, and control panel components.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Lencore; Gold or comparable product by one of the following:

1. Cambridge Sound.
2. Dynasound, Inc.
3. Soft dB.

C. Standard: Comply with ASTM E1374.

D. Network:

1. Provide an Ethernet LAN to connect controller/gateways to a PC running a Microsoft Windows operating system, macOS, or iOS.
2. Ethernet Protocols: Comply with and be compatible with **1000 BASE-T** routers and networks.
3. Network communications protocol to be **IP**
4. Network controls to be available at the control panel **and** using a PC connected to the control network,

E. Network Control Panel. Single, system control for entire building or buildings by providing operation of multiple system components from a single, central location.

1. Connections.
   a. Comply with UL 60065.
   b. Power Supply: NFPA 70, Class 2.
   c. Ethernet Connection: TIA 485.
   d. Serial Connection: RS-232 port.
   e. Output to Loudspeaker Control Units: NFPA 70, Class 2.
2. Sound-Masking Performance: Digital signal processing (DSP) technology for masking sound generation and output adjustment of masking signals.
   a. Masking Sound: Generated via a truly random, non-deterministic digital process with no repeat cycle within a 24-hour period.
   b. System Requirements:
      1) Single Control Unit: Capable of addressing entire system. Multiple control units not acceptable.
      2) Integrated Sound-Masking Digital Signal Processors (DSPs): Utilize an open platform network technology, meeting open control standards with web appliances, browser interfaces, infrared remote controls, and internet access capable.
      3) Capable of separately and independently configuring zones for sound masking via the network, zoned through its singular central control.
      4) Sound-Masking System Shutdown: Through interface with FACU as described in Section 283100 "Intrusion Detection."
         a) Compliance: UL 2572.
      5) Control System: Capable of using TCP/IP for intelligent building integration.
      6) Standards for Open Platform: Comply with ANSI/CEA 709.1.
      7) US Army Corp.'s Unified Facilities Guide Specifications:

a) UFGS 25 10 10, "Utilities Monitoring and Control System."
b) UFGS 23 09 23, "Direct Digital Control for HVAC and Other Local Building Controls."

8) Multi-drop network system; point-to-point systems are unacceptable.
9) System Tuning: Through **network**
10) Complete diagnostics capability of entire system functions including diagnostics of network, hubs, nodes, routers, DSP, relays, memory, circuitry, amplifiers, and power.
11) Report entire settings for each zone, indicating at a minimum the volume, contour, equalization, diagnostics, and zones and channel groupings.
12) Diagnostics and remote administration via a standard web browser.
13) Capable of naming network nodes, channels, zones, and external audio sources via its integrated graphical user interface.
14) Equalizer: 30-Band

3. Sound-masking adjustment for each loudspeaker control unit:

a. Masking Sound: 20 Hz to 20 kHz, with equalizers for adjusting the masking-sound spectrum at third-octave resolution.

b. Masking-Sound Volume Adjustment: Digital control, adjustable in 0.5-dBA increments over the range of 34 to 82.5 Dba or a continuous adjustment within that range.

c. Twenty-eight (28) preset contour options. Adjust contour from minus 14 to plus 14.

F. Control Network Software: Microsoft, Windows, macOS, or iOS based.

1. Description of Functions:

a. Communicate with network control panel(s) to assign device addresses and to configure network hardware.

b. Security: 128-bit AES encryption and user passwords.

c. Setup data to be saved in electronic and printed formats.

G. Sound-Masking Loudspeaker Control Unit: Addressable, connected to the sound-masking system control network. Unit has no physical controls; all settings to be from the network control panel.

1. Masking-Sound Generator: Digital, solid-state, random sequence noise generator, stable in sound spectrum and output level, and containing the following:

a. Electronic sound amplifier and equalizers for shaping the masking-sound spectrum, complying with ASTM E1374.

b. Masking Sound: **20 Hz to 20 kHz** with equalizers for adjusting the masking-sound spectrum at third-octave resolution.

c. Masking-Sound Volume Adjustment: At least 10 steps at 0.5 dB each, or a continuous adjustment within that range.

d. Independent zoning of sound masking

e. Inline Speakers: Speakers with independent potentiometer allowing individual speaker adjustment control outside of networked zoned controls.

2. Diagnostic functions specified at the network control panel.

3. Enclosure: One RU high, rack mounted, metal enclosure.

H. Sound-Masking Loudspeakers: Connected to a loudspeaker control unit.

1. Cone Type: 4 inches (102 mm) in diameter with 1-inch (25-mm) voice coil and minimum 10-oz. (283-g) ceramic magnet, mounted in an acoustic enclosure ensuring delivery of a broad frequency spectrum.

2. Rated Output Level: 10 W.

3. Dispersion Angle: 120 degrees.

4. Sensitivity: 88-dB sound-pressure level (SPL) at 1 W/m on the reference axis.

5. Audio Output: 83 dB, maximum for both masking sound and paging/music.

6. Frequency Response: Plus or minus 3 dB from 85 to 13,000 Hz.

7. Enclosure: Metal acoustic enclosure, housing the loudspeaker, its connections, and controls.

8. Mounting:

a. For pendant mounted speakers, arrange units for downward dispersion and include accessories required for mounting to the building structure.

b. For flush-with-ceiling mounting, arrange units for downward dispersion and equip with a perforated grill and accessories required for mounting in the suspended ceiling system.

I. Power Supplies: Comply with UL 1310, Class 2.

## 2.3 WIRE AND CABLE

A. Comply with Section 271513 "Communications Copper Horizontal Cabling" for balanced twisted pair cabling.

B. Category 5e Twisted Pair Cable: Four-pair, balanced-twisted pair cable, certified to comply with transmission characteristics of Category 5e cable at frequencies of up to 100 MHz.

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

a. CommScope, Inc.

2. 100-ohm, 24 AWG solid copper.

3. **Shielded twisted pairs (FTP)**

C. Loudspeaker Wire and Cables:

1. Plenum-Rated Paired Cable: NFPA 70, Type CMP.

2. Lead Content: Less than 300 parts per million.

D. Control-Circuit Conductors:

1. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Comply with NECA 1.

B. Install in accordance with manufacturer's instructions based upon approved system design and submittals. Follow manufacturer's installation manual.

C. General Contractor: Responsible for supplying any conduit, which may be required to complete system installation in accordance with specifications and local building codes.

D. Loudspeaker Assemblies: Suspend with chains from building structure above ceilings, so bottom of assembly is 6 to 8 inches (150 to 200 mm) above upper plane of finished ceiling material. Use eyebolts on speaker assemblies for attachment. Suspend independently from structure, not to supports for components of other building systems.

E. Loudspeaker Connections: For two- or three-channel systems, connect loudspeaker assemblies alternatively, so masking sound is redundant throughout coverage zones.

F. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and unless otherwise indicated.

1. Except raceways are not required in accessible indoor ceiling spaces and attics.

2. Except raceways are not required in hollow gypsum board partitions.

3. Conceal raceways and wiring, except in unfinished spaces.

G. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."

3. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

I. Exposed Cable: Install parallel to building lines, follow surface contours, and support as recommended by manufacturer.

J. Grounding: As recommended by manufacturers unless more stringent requirements are indicated. Ground equipment and conductors to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments with a maximum of 5 ohms to ground at main equipment location. **Measure, record, and report ground resistance.**

K. Impedance Matching: For system components, including connecting cable, provide end-to-end level and impedance-matched signal paths. Use matching networks and balancing devices at connections where necessary to avoid mismatches.

L. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

M. Final connection to FACU will be completed by fire alarm system installer.

## 3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Use color-coded conductors, and apply wire- and cable-marking tape to designate wires and cables, so media are identified in coordination with system wiring diagrams.

C. Label loudspeakers as to channel, zone, and address.

## 3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections **with the assistance of a factory-authorized service representative**.

E. Tests and Inspections:

1. Operational Test: Start system to confirm proper operation. Remove malfunctioning units, replace with new units, and retest. Make initial sound-spectrum and -level adjustments for each zone.

2. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

3. Pretesting: Tune, align, and adjust system, and pretest components, wiring, and functions to verify compliance with specified material, installation, and performance requirements. Correct deficiencies and retest until satisfactory performance and conditions are achieved.

4. Masking Sound-Power Level Adjustments: Adjust independently for each space to minimum level between **40** and 50 dBA that will provide speech privacy between adjacent workstations while complying with other system requirements.

F. Final Acceptance Testing: Provide a minimum of 10 days' notice of acceptance test performance schedule. Schedule tests after pretesting has been successfully completed.

1. Perform sound-masking evaluation tests in accordance with **ASTM E1130 ASTM E1573**, with measurements and calculations in accordance with ANSI S3.5. Report test results in accordance with the requirements in **ASTM E1130 ASTM E1573**.

2. Tests and Calibration Conditions: Spaces to be completely furnished but unoccupied; lights and HVAC systems to be on; HVAC system testing and balancing to be completed; and electronic ballasts, lighting relay panels, and low-voltage transformers to be in place.

3. Test Conditions: Complying with ASTM E1130 and calculated in accordance with ANSI S3.5.

4. Instrumentation: Use a professional-quality, sound-level meter with octave-band filters and documentation of recent calibration against recognized standards. Comply with ANSI S1.4-1.

5. Record test observations, readings, and corrective actions.

6. System Tests: Include the following for each system zone:

   a. Loudspeaker Circuit Impedance Test: Measure impedance at 1000 Hz with amplifier disconnected, using a professional impedance meter or bridge. Locate and correct faults denoted by abnormal readings.

   b. Ambient Sound-Level Tests: With system off, measure ambient sound level in one-third octave bands. Also measure ambient sound level as a single, wide-band, A-weighted reading.

   c. System Noise Test: With masking-noise signal on and amplifiers adjusted at a working level 10 dB above ambient sound level, check for hum, buzz, rattle, or other operating deficiencies.

   d. Spatial Uniformity Test: Measure sound level at locations no greater than 15 ft. (4.6 m) o.c. throughout covered spaces to determine compliance with specified performance level.

   e. Frequency Response Adjustment and Test: Adjust one-third octave frequency bands and other unit filters to provide response. Adjust to meet requirement of space speech intelligibility and quality of background sound. Comply with ANSI S3.2, CTA 426, and ASTM E1110.

7. Adjust level of masking sound that is appropriate for the area and the overall volume.

8. Adjust level of masking sound for each space, so one-third octave band centered at 500 Hz has final selected sound-power level for that space. Measure deviation from listed values in one-third octave bands from 100 to 1000 Hz. Measured values must not deviate from those listed by more than four dB for open-plan areas and eight dB for enclosed offices. The total of individual band deviations in eight bands must not exceed 16 dB for open-plan areas and 30 dB for enclosed offices.
9. Walk-Through Test: People in covered spaces cannot discern loudspeaker locations.
10. Where required, space to comply with HIPPA (45 CFR, Parts 160 and 164) for privacy.
11. Where required, space to comply with the Gramm-Leach Bliley Act to protect consumer personal and financial information in open office layouts.

G. Retest: Correct deficiencies identified by tests and observations, and retest until compliance with specified requirements is achieved.

H. Recording Control Settings and System Adjustments: Record final control settings and programming, and final tap setting of loudspeaker-matching transformers. Record final sound-level measurements and observations.

## 3.4 ADJUSTING

A. Occupancy Adjustments: When requested within **12** months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

## 3.5 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement to include software support for **two**y ears.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within **two** years from date of Substantial Completion. Upgrading software to include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least **30** days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

## 3.6 DEMONSTRATION

A. **Engage a factory-authorized service representative to train Owner's maintenance** personnel to adjust, operate, and maintain services.

**END OF SECTIO**N

# SECTION 28 0526 – GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.

### 1.3 DEFINITIONS

A. Signal Ground: The ground reference point designated by manufacturer of the system that is considered to have zero voltage.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS

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

1. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

## 2.2 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

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

C. Basis-of-Design Product:

1. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.
3. Harger Lightning and Grounding.
4. Panduit Corp.
5. Tyco Electronics Corp.

D. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

E. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

## 2.3 GROUNDING BUSBARS

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

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.

B. Grounding Busbars: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm) in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.)
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches (1827 or 914 mm long), with stainless-steel or copper-plated hardware for attachment to the rack.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Bond shields and drain conductors to ground at only one point in each circuit.

B. Signal Ground:

1. For each system, establish the signal ground and label that location as such.

2. Bond the signal ground to the alternating-current (ac) power system service by connecting to one of the following listed locations, using insulated No. 6 AWG, stranded, Type THHN wire:
   a. Grounding bar in an electrical power panelboard if located in the same room or space as the signal ground.
   b. Telecommunications grounding busbar.

C. Comply with NECA 1.

## 3.2 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding and Bonding Conductors:
1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.

## 3.3 CONNECTIONS

A. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

B. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

C. Shielded Cable: Bond the shield of shielded cable to the signal ground. Comply with TIA/EIA-568-C.1 and TIA/EIA-568-C.2 when grounding screened, balanced, twisted-pair cables.

D. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

## 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

**END OF SECTION**

# SECTION 28 0528 – PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetallic conduits, tubing, and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wire ways and auxiliary gutters.
5. Nonmetallic wire ways and auxiliary gutters.
6. Boxes, enclosures, and cabinets.
7. Hand holes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 0543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
2. Section 26 0533 "Raceways and Boxes for Electrical Systems" for conduits, wire ways, surface raceways, boxes, enclosures, cabinets, hand holes, and faceplate adapters serving electrical systems.
3. Section 27 0528 "Pathways for Communications Systems" for conduits, surface pathways, inner duct, boxes, and faceplate adapters serving communications systems.

### 1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

### 1.4 ACTION SUBMITTALS

A. Product Data: For wire ways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

D. Samples: For wire ways, nonmetallic wire ways and surface pathways and for each color and texture specified, 12 inches (300 mm) long.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, and equipment racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.

D. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Alpha Wire Company.
4. Anamet Electrical, Inc.
5. Electri-Flex Company.
6. O-Z/Gedney.
7. Picoma Industries.
8. Republic Conduit.
9. Robroy Industries.
10. Southwire Company.
11. Thomas & Betts Corporation.
12. Western Tube and Conduit Corporation.
13. Wheatland Tube Company.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit, IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2. Fittings for EMT:
   a. Material: Steel or die cast.
   b. Type: Setscrew or compression.
3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 467, rated for environmental conditions were installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Anamet Electrical, Inc.
4. Arnco Corporation.
5. CANTEX Inc.
6. CertainTeed Corporation.
7. Condux International, Inc.
8. Electri-Flex Company.
9. Kraloy.
10. Lamson & Sessions; Carlon Electrical Products.
11. Niedax-Kleinhuis USA, Inc.
12. RACO; Hubbell.
13. Thomas & Betts Corporation.

B. General Requirements for Nonmetallic Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

C. ENT: Comply with NEMA TC 13 and UL 1653.

D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. LFNC: Comply with UL 1660.

F. Rigid HDPE: Comply with UL 651A.

G. Continuous HDPE: Comply with UL 651B.

H. RTRC: Comply with UL 1684A and NEMA TC 14.

I. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

J. Fittings for LFNC: Comply with UL 514B.

K. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

L. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

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

1. Alpha Wire Company.
2. Arnco Corporation.
3. Endot Industries Inc.
4. IPEX.
5. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum riser or general-use installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-C.

## 2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Mono-Systems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 Type 3R Type 4 Type 12, dependent on environmental conditions, unless otherwise indicated, and sized according to NFPA 70.

1. Metal wire ways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with TIA-569-C.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wire ways as required for complete system.

D. Wire way Covers: Hinged type, Screw-cover type or Flanged-and-gasketed type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

## 2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

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

1. Allied Moulded Products, Inc.

2. Hoffman.

3. Lamson & Sessions; Carlon Electrical Products.

4. Niedax-Kleinhuis USA, Inc.

B. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with TIA-569-C.

C. Description: Fiberglass polyester extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having Snap-On cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wire ways as required for complete system.

F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.6 BOXES, ENCLOSURES, AND CABINETS

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

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. Hoffman.
6. Lamson & Sessions; Carlon Electrical Products.
7. Milbank Manufacturing Co.
8. Molex.
9. Mono-Systems, Inc.
10. O-Z/Gedney.
11. Quazite:Hubbell Power Systems, Inc.
12. RACO; Hubbell.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-C.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy aluminum, Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable, Semi-adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a q
5. Shape: Rectangular. Qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum, galvanized, cast iron with gasketed cover.

J. Device Box Dimensions: 4-inches square by 2-1/8 inches deep (100 mm square by 60 mm deep), 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep).

K. Gangable boxes are prohibited.

L. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 and Type 12, (dependent on environmental conditions), with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:
   a. Material: Plastic, Fiberglass.
   b. Finished inside with radio-frequency-resistant paint.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:

1. NEMA 250, Type 1, Type 3R and Type 12, (dependent on environmental conditions), galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panel boards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

A. General Requirements for Hand holes and Boxes:

1. Boxes and hand holes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Comply with TIA-569-C.
4. Hand holes/Manholes shall be traffic rated when installed in parking lots, access roads and streets.

B. Polymer-Concrete Hand holes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. NewBasis.
   d. Oldcastle Precast, Inc; Christy Concrete Products.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open, closed, integral closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhold location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC.".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Hand holes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhold and Pull-Box Prototype Test: Test prototypes of hand holes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC, IMC, RNC, Type EPC-40-PVC, RNC, Type EPC-80-PVC.
2. Concealed Conduit, Aboveground: GRC, IMC, EMT, RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-40-PVC, Type EPC-80-PVC, direct buried concrete encased.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC, LFNC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R, Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT, ENT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT, RNC identified for such use.
3. Exposed and Subject to Severe Physical Damage: GRC, IMC. Pathway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums
4. Concealed in Ceilings and Interior Walls and Partitions: EMT, ENT or RNC, Type EPC-40-PVC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric-Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC, IMC.
7. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, Plenum-type, communications-cable pathway, EMT.
8. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway, Riser-type, communications-cable pathway, EMT.

9. Pathways for Concealed General Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway, Riser-type, optical-fiber-cable pathway, Plenum-type, optical-fiber-cable pathway, General-use, communications-cable pathway, Riser-type, communications-cable pathway Plenum-type, communications-cable pathway, EMT.

10. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel, nonmetallic in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. EMT: Use setscrew or compression, steel, cast-metal fittings. Comply with NEMA FB 2.10.

4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg. F (49 deg. C).

## 3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-C for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches (300 mm) of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches (300 mm) of enclosures to which attached.

I. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
3. Arrange pathways to keep a minimum of 1 inch (25 mm), 2 inches (50 mm) of concrete cover in all directions.
4. Do not embed thread less fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to RNC, Type EPC-40-PVC, GRC or IMC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end

of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

R. Surface Pathways:

1. Install surface pathway for surface electrical outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points. Secure surface pathway with screws or other anchor-type devices at intervals not exceed ing 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

T. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway sealing fittings according to NFPA 70.

U. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

W. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg. F (17 deg. C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg. F (55 deg. C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg. F (70 deg. C) temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg. F (86 deg. C) temperature change.

c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg. F (70 deg. C) temperature change.

d. Attics: 135 deg. F (75 deg. C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg. F (0.06 mm per meter of length of straight run per deg. C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg. F (0.0115 mm per meter of length of straight run per deg. C) of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a rain-tight connection between boxes and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

CC. Set metal floor boxes level and flush with finished floor surface.

DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

## 3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.

2. Install backfill as specified in Section 312000 "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.

   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.

7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

## 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install hand holes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install hand holes with bottom below frost line and in accordance within manufacturer’s guidelines.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

## 3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electronic Safety and Security Pathways and Cabling."

## 3.6 FIRESTOPPING

A. Install fire stopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 8413 "Penetration Fire stopping."

## 3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION**

# SECTION 28 0544 – SLEEVES AND SLEEVE SEALS FOR ELECTRONIC SAFETY AND SECURITY PATHWAYS AND CABLING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
2. Penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies and smoke barriers, with and without penetrating items.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## PART 2 - PRODUCTS

### 2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

### 2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Advance Products & Systems, Inc.
   b. CALPICO, Inc.
   c. Metraflex Company (The).
   d. Pipeline Seal and Insulator, Inc.
   e. Proco Products, Inc.

2. Sealing Elements: EPDM, Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Carbon steel, Plastic, Stainless steel.

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

## 2.3 SLEEVE-SEAL FITTINGS

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

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

a. Presealed Systems.

## 2.4 GROUT

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

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

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

D. Packaging: Premixed and factory packaged.

## 2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel, cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

## 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.3 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

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

**END OF SECTION**

# SECTION 28 1300 – ACCESS 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:

1. Security access central-control station.
2. One or more security access networked workstations.
3. Security access operating system and application software.
4. Security access controllers connected to high-speed electronic-data transmission network.

### 1.3 DEFINITIONS

A. CCTV: Closed-circuit television.

B. CPU: Central processing unit.

C. Credential: Data assigned to an entity and used to identify that entity.

D. Dpi: Dots per inch.

E. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

F. GFI: Ground fault interrupter.

G. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

H. I/O: Input/Output.

I. LAN: Local area network.

J. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A

communications loop. Where this term is presented with an initial capital letter, this definition applies.

K. PC: Personal computer. Applies to the central station, workstations, and file servers.

L. PCI Bus: Peripheral Component Interconnect. A peripheral bus providing a high-speed data path between the CPU and the peripheral devices such as a monitor, disk drive, or network.

M. PDF: Portable Document Format. The file format used by the Acrobat document-exchange-system software from Adobe.

N. RAS: Remote access services.

O. RF: Radio frequency.

P. ROM: Read-only memory. ROM data are maintained through losses of power.

Q. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

R. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

S. UPS: Uninterruptible power supply.

T. USB: Universal serial bus.

U. WAN: Wide area network.

V. WAV: The digital audio format used in Microsoft Windows.

W. WMP: Windows media player.

X. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

Y. Windows: Operating system by Microsoft Corporation.

Z. Workstation: A PC with software that is configured for specific, limited security-system functions.

AA. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

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

1. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

2. Cable Administration Drawings: As specified in "Identification" Article.

C. Samples: For each exposed product and for each color and texture specified.

D. Other Action Submittals:

1. Project planning documents as specified in Part 3.

## 1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Microsoft Windows software documentation.

2. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.

3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

4. System installation and setup guides with data forms to plan and record options and setup decisions.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Alarm Printer Black/Red Ribbons: Package of 12.

2. Laser Printers: Three toner cassettes and one replacement drum unit.

3. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.

4. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

## 1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

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

D. Comply with NFPA 70, "National Electrical Code."

E. Comply with SIA DC-01 and SIA DC-03and SIA DC-07.

## 1.9 DELIVERY, STORAGE, AND HANDLING

A. Central Station, Workstations, and Controllers:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg. F (10 and 30 deg. C), and not more than 80 percent relative humidity, noncondensing.

2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.

4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

## 1.10 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg. F (16 to 30 deg. C) and a relative humidity of 20 to 80 percent, noncondensing.

2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg. F (2 to 50 deg. C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

3. Outdoor Environment: NEMA 250, NEMA 250, Type 3, Type 3R, Type 3S, Type 4 and Type 4X enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg. F (minus 34 to plus 50 deg. C) dry bulb and 20 to 90 percent relative humidity, condensing.

Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h)and snow cover up to 24 inches (610 mm) thick.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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

1. Blackboard, Inc. – Transact, (New building shall tie into existing Blackboard Transact System)

### 2.2 DESCRIPTION

A. NMSU Standard – SA3000 Door Access System as manufactured by Blackboard, Inc.

B. Security Access System: PC-based central station, one or more networked PC-based workstations, and field-installed controllers, connected by a high-speed electronic-data transmission network.

C. Network connecting the central station and workstations shall be a LAN, WAN using Microsoft Windows-based TCP/IP with a capacity of connecting up to 99 workstations. System shall be portable across multiple communication platforms without changing system software.

D. Network(s) connecting PCs and controllers shall consist of one or more of the following:

1. Local area, IEEE 802.3 Fast Ethernet Gigabit-Ethernet, 100 BASE-TX, star topology network based on TCP/IP.
2. Direct-connected, RS-232 cable from the COM port of the central station to the first controller, then RS-485 cable to interconnect the remaining controllers at that Location.
3. Dial-up and cable modem connection using a standard cable or dial-up telephone line.

### 2.3 SYSTEM DATABASE

A. Existing Blackboard Transact System and Software

### 2.4 SURGE AND TAMPER PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

## 2.5 CONTROLLERS

A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central station or workstation for controlling its operation. Controllers are to be located in a centrally located ER/TR.

B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.

C. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.

D. Alarm Annunciation Controller:

1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network, with dc line supervision on each of its alarm inputs.

a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.

b. Alarm-Line Supervision:

1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal, and for conditions as described in UL 1076 for line security equipment by monitoring for abnormal open, grounded, or shorted conditions using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of 5 percent or more for longer than 500 ms.

2) Transmit alarm-line-supervision alarm to the central station during the next interrogation cycle after the abnormal current condition.

c. Outputs: Managed by central-station software.

2. Auxiliary Equipment Power: A GFI service outlet inside the controller enclosure.

E. Entry-Control Controller:

1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.

a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.

b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:

1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.

2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.

c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.

2. Inputs:

a. Data from entry-control devices; use this input to change modes between access and secure.

b. Database downloads and updates from the central station that include enrollment and privilege information.

3. Outputs:

a. Indicate success or failure of attempts to use entry-control devices and make comparisons of presented information with stored identification information.

b. Grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.

c. Maintain a date-, time-, and Location-stamped record of each transaction and transmit transaction records to the central station.

d. Door Prop Alarm: If a portal is held open for longer than 20 seconds, alarm sounds.

4. With power supplies sufficient to power at voltage and frequency required for field devices and portal-control devices.

5. Data Line Problems: For periods of loss of communication with the central station, or when data transmission is degraded and generating continuous checksum errors, the controller shall continue to control entry by accepting identifying information, making authentication decisions, checking privileges, and controlling portal-control devices.

a. Store up to 1000 transactions during periods of communication loss between the controller and access-control devices for subsequent upload to the central station on restoration of communication.

6. Controller Power: NFPA 70, Class II power-supply transformer, with 12- or 24-V ac secondary, backup battery and charger.

a. Backup Battery: Premium, valve -regulated, recombinant-sealed, lead-calcium battery; spill proof; with a full one-year warranty and a pro rata 9-year warranty. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.

b. Backup Battery: Valve-regulated, recombinant-sealed, lead-acid battery; spill proof. With single-stage, constant-voltage-current, limited battery charger, comply with battery manufacturer's written instructions for battery terminal voltage and charging current recommendations for maximum battery life.

c. Backup Power-Supply Capacity: 90 minutes of battery supply. Submit battery and charger calculations.

d. Power Monitoring: Provide manual, dynamic battery-load test, initiated and monitored at the control center; with automatic disconnection of the controller when battery voltage drops below controller limits. Report by using local controller-mounted digital displays and by communicating status to central station. Indicate normal power on and battery charger on trickle charge. Indicate and report the following:

1) Trouble Alarm: Normal power-off load assumed by battery.

2) Trouble Alarm: Low battery.

3) Alarm: Power off.

## 2.6 SECONDARY ALARM ANNUNCIATOR

A. Secondary Alarm Annunciation Site: A workstation with limited I/O capacity, consisting of a secondary alarm annunciation workstation to allow the operator to duplicate functions of the main operator interface and to show system status changes.

## 2.7 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

A. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.

2. Indoors, uncontrolled environment.

3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

D. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Stripe Swipe Readers: Bidirectional, reading cards swiped in both directions, powered by the controller. Reader shall be set up for ABA Track.

1. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.
2. Readers for outdoors shall be in a polymeric plastic enclosure with all electronics potted in plastic. Rated for operation in ambient conditions of minus 40 to plus 160 deg F (minus 40 to plus 70 deg C) in a humidity range of 10 to 90 percent.

F. Touch-Plate and Proximity Readers:

1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
2. Passive-detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
3. The card reader shall read proximity cards in a range from direct contact to at least 6 inches (150 mm) from the reader.

## 2.8 PUSH-BUTTON SWITCHES

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

1. Securitron Magnalock Corporation; an ASSA ABLOY Group company or approved equal.

B. Push-Button Switches: Momentary-contact back-lighted push buttons with stainless-steel switch enclosures.

C. Electrical Ratings:

1. Minimum continuous current rating of 10 A at 120-V ac or 5 A at 240-V ac.
2. Contacts that will make 720 VA at 60 A and that will break at 720 VA at 10 A.

D. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.

E. Enclosures shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors.

F. Power: Push-button switches shall be powered from their associated controller, using dc control.

## 2.9 DOOR HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm and annunciate a local alarm. Exit device and alarm contacts are specified in Section 087100 "Door Hardware."

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Section 087100 "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power-line supervision. Signal switches shall transmit data to controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and they shall report a forced entry. Power and signal shall be from the controller. Electric strikes are specified in Section 087100 "Door Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power-line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the controller. Electromagnetic locks are specified in Section 087100 "Door Hardware."

## 2.10 TIA 232-F ASCII INTERFACE SPECIFICATIONS

A. ASCII interface shall allow TIA 232-F connections to be made between the control station operating as the host PC and any equipment that will accept TIA 232-F ASCII command strings, such as CCTV switches, intercoms, and paging systems.

1. Alarm inputs in system shall allow for individual programming to output up to four unique ASCII character strings through two different COM ports on the host PC.
2. Inputs shall have the ability to be defined to transmit a unique ASCII string for alarm and one for restore through one COM port, and a unique ASCII string for a nonalarm, abnormal condition and one for a normal condition through the same or different COM port.
3. Predefined ASCII character strings shall have the ability to be up to 420 characters long with full use of all the ASCII control characters, such as return or line feed. Character strings shall be defined in the system database and then assigned to the appropriate inputs.
4. COM ports of the host PC used to interface with external equipment shall be defined in the setup portion of the software. COM port's baud rate, word length, stop bits, and parity shall be definable in the software to match that of the external equipment.

B. Pager-System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.

1. TIA 232-F output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to the paging system. This interface shall support both numeric and alphanumeric pagers.

C. Alarm-System Interface:

1. TIA 232-F output shall be capable of transmitting alarms from other monitoring and alarm systems to central-station automation software.
2. Alternatively, alarms that are received by this access-control system are to be transferred to the alarm automation system as if they were sent through a digital alarm receiver.

a. System shall be able to transmit an individual message from any alarm input to a burglar-alarm automation monitoring system.

b. System shall be able to append to each message a predefined set of character strings as a prefix and a suffix.

## 2.11 FLOOR-SELECT ELEVATOR CONTROL

A. A. Elevator access control shall be integral to security access.

1. System shall be capable of providing full elevator security and control through dedicated controllers without relying on the control-station host PC for elevator control decisions.

2. Access-control system shall enable and disable car calls on each floor and floor-select buttons in each elevator car, restricting passengers' access to the floors where they have been given access.

3. System setup shall, through programming, automatically and individually secure and unsecure each floor-select button of a car by time and day. Each floor-select button within a car shall be separately controlled so that some floors may be secure while others remain unsecure.

B. When a floor-select button is secure, it shall require the passenger to use his or her access code and gain access to that floor before the floor-select button will operate. The passenger's credential shall determine which car call and floor-select buttons are to be enabled, restricting access to floors unless authorized by the system's access code database. Floor-select button shall be enabled only in the car where the credential holder is the passenger.

C. Security access system shall record which call button is pressed, along with credential and time information.

1. System controller shall record elevator access data.

2. The controller shall reset all additional call buttons that may have been enabled by the user's credential.

3. The floor-select elevator control shall allow for manual override from a workstation PC either by individual floor or by cab.

## 2.12 CABLES

A. A. General Cable Requirements: Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security" and as recommended by system manufacturer for integration requirement.

B. Composit cable, Plenum Rated, consisting of the following: (Controller to Junction box at door location)

1. 4 conductor, 18 AWG shielded

2. 3 pair, 22AWG Shielded.

3. 2 conductor, 22 AWG, shielded.

4. 4 conductor, 22 AWG, shielded

5. NFPA 70, Type CMP.
6. Flame Resistance: NFPA 262 flame test.

C. Junction box to door hardware cabling;
1. See sheet E-510 for breakdown of required cabling

D. Elevator Travel Cables:
1. Steel center core with shielded, twisted pairs, No. 20 AWG conductor size.
2. Steel center core support shall be pre-formed, flexible, low-torsion, zinc-coated, steel wire rope; insulated with 60 deg C flame-resistant PVC and covered with a nylon or cotton braid.
3. Shielded pairs shall be insulated copper conductors; color-coded, insulated with 60 deg C flame-resistant PVC; each pair shielded with bare copper braid for 85 percent coverage.
4. Electrical grade, dry jute filler.
5. Helically wound synthetic fiber binder.
6. Rayon or cotton braid applied with 95 percent coverage.
7. 60 deg C PVC jacket specifically compounded for flexibility and abrasion resistance; and complying with UL VW-1 and CSA FT1 flame rated.

E. LAN Cabling:
1. Comply with requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security," And section 27 1500, “Communications Horizontal Cabling”.
2. NFPA 262.

## 2.13 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

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

## 3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.
10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format using Visio or Cad.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

## 3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

G. Install end-of-line resistors at the field device location and not at the controller or panel location.

## 3.4 CABLE APPLICATION

A. Comply with TIA 569-C, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. (15 m).

D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. (1220 m).

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. (75 m) 500 ft. (150 m).

G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. (8 m).

## 3.5 GROUNDING

A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

## 3.6 INSTALLATION

A. Access Control contractor is to provide a complete “Turn-Key” installation that is tied into existing “Blackboard Transact” system.

B. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch- (6.4-mm-) high text and symbols as required. Push-button switches shall be connected to the controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

C. Install card readers, keypads, push buttons where required. Refer to plans for all locations.

## 3.7 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with TIA/EIA 606-B.

B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.

2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

## 3.8 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

## 3.9 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. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-C.1.

2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.

3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

4. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

## 3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.

2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

## 3.11 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

## 3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.

2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.

3. Security personnel.

4. Hardware maintenance personnel.

5. Corporate management.

**END OF SECTION**

# SECTION 28 1600 – INTRUSION DETECTION

## 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 intrusion detection with communication links to perform monitoring, alarm, and control functions. Contractor is responsible for providing and installing a complete “turn-key” Intrusion system that meets or exceeds the specifications listed below.

B. Contractor shall coordinate with NMSU PD to confirm make/models of Intrusion Systems components prior to purchasing and submitting product information.

C. Related Sections:

1. Section 28 2300 "Video Surveillance" for CCTV cameras that are used as devices for video motion detection.

### 1.3 DEFINITIONS

A. Control Unit: System component that monitors inputs and controls outputs through various circuits.

B. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

C. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

D. Standard Intruder: A person who weighs 100 lb (45 kg) or less and whose height is 60 inches (1525 mm) or less; dressed in a long-sleeved shirt, slacks, and shoes unless environmental conditions at the site require protective clothing.

E. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

### 1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.

C. UPS: Sizing calculations.

1. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
2. Master Control-Unit Console Layout: Show required artwork and device identification.
3. Device Address List: Coordinate with final system programming.
4. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
5. Details of surge-protection devices and their installation.
6. Sensor detection patterns and adjustment ranges.

D. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

E. Samples: For units with factory-applied color finishes.

## 1.5 QUALIFICATIONS

A. Communications Cabling: The Contractor shall have 5 (five) years of documented experience performing cable placement, splicing, termination, connecting, and testing for each of the media types and 3 (three) years of applicable experience with the proposed system manufacturer. In the case of newer technologies that do not have a 3 (three) year history, the Contractor shall have documented experience for at least half of the lifetime of the new technology. The approved contractor shall, at a minimum, maintain a ratio of one manufacturer or BICSI certified installer for every two non-certified installers assigned to the project.

1. The contractor shall provide resumes for the Project Manager, Supervisors and any skilled technicians or installers. Each resume shall include applicable certification documents provided by the manufacturer or BICSI.
2. Project Manager, Supervisors, and Principal Skilled Technicians: minimum of 5 years' experience in like work.
3. Category 6 Unshielded Twisted Pair and Fiber Optic Cable Technicians: documented training, licensing, and/or certification for the types of media specified, as applicable as well as certification from the manufacturer of the solution chosen by the owner.

## 1.6 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. Warranty: Sample of special warranty

## 1.7 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

## 1.8 MAINTENANCE MATERIAL SUBMITTALS

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

1. Intrusion Detection Devices: Furnish quantity equal to five percent of the number of units of each type installed, but no less than one of each type.
2. Fuses: Three of each kind and size.
3. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
4. Security Fasteners: Furnish no less than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

## 1.9 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer

1. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International
2. An employer of workers, at least one of whom is a technician certified by the National Burglar & Fire Alarm Association.
3. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain controllers, sensors, and all software through one source from single manufacturer.

C. Testing Agency Qualifications: Member Company of NETA or an NRTL.

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

E. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

F. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.

G. Comply with NFPA 70.

## 1.10 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to 4000 feet (1220 m).
2. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg. F (16 to 29 deg. C) and a relative humidity of 20 to 80 percent, noncondensing.
3. Interior, Controlled Environment: System components, except master control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient of 36 to 122 deg. F (2 to 50 deg. C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient of 0 to 122 deg. F (minus 18 to plus 50 deg. C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
5. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient of minus 30 to plus 122 deg. F (minus 34 to plus 50 deg. C) dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick.
6. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flying’s shall be rated, listed, and installed according to NFPA 70.

## 1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Description: Hard-wired, Multiplexed, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

B. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.
3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

D. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

E. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
5. Protected Zone Test: Initiate operational test of a specific protected zone.
6. System Test: Initiate system-wide operational test.
7. Print reports.

F. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

G. Automatic Control of Related Systems: Alarm or supervisory signals from certain intrusion detection devices control the following functions in related systems:

1. Switch selected lights.
2. Shift elevator control to a different mode.
3. Open a signal path between certain intercommunication stations.
4. Shift sound system to "listening mode" and open a signal path to certain system speakers.
5. Place’s calls to the safety director and principles once an event has transpired.

H. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit

receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

I. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.

J. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

K. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

L. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

## 2.2 SYSTEM COMPONENT REQUIREMENTS

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 26 4313 "Surge Protection for Low-Voltage Electrical Power Circuits."

2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

B. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

C. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

D. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.

E. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

F. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

G. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

H. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

## 2.3 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, fiberglass, stainless steel.

D. Corrosion Resistant: NEMA 250, Type 4X, PVC, stainless steel.

E. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

## 2.4 SECURE AND ACCESS DEVICES

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

1. Honeywell, Inc; ADEMCO products
2. Tyco.
3. Owner and Consultant Approved Equal

B. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

C. Key-Operated Switch: Change protected zone between secure and access conditions.

## 2.5 DOOR AND WINDOW SWITCHES

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

1. Honeywell International Inc.; Honeywell Security.
2. Tyco
3. Owner and Consultant approved equal

B. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.

C. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.

D. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

## 2.6 PIR SENSORS

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

1. Honeywell International Inc.; Honeywell Security.
2. Tyco
3. Owner and Consultant Approved Equal

B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

C. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.

1. Wall-Mounted Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet (15 m). Provide adjustable coverage pattern as indicated.
2. Ceiling-Mounted Unit Spot-Detection Pattern: Full 360-degree conical.
3. Ceiling-Mounted Unit Pattern Size: 84-inch (2135-mm) diameter at floor level for units mounted 96 inches (2440 mm) above floor; 18-foot (5.5-m) diameter at floor level for units mounted 25 feet (7.6 m) above floor.

D. Device Performance:

1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg. F (1 deg. C) or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s) across two adjacent segments of detector's field of view.

2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.

## 2.7 MICROWAVE INTRUSION DETECTORS (INTERIOR)

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

1. Honeywell International Inc.; Honeywell Security.
2. Tyco
3. Owner and Consultant Approved Equal

B. Device Performance: Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.

1. Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps (0.09 to 2.3 m/s). Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
2. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.

## 2.8 MASTER CONTROL UNIT

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

1. Tyco.
2. Honeywell International Inc.; Honeywell Security.
3. Owner and Consultant Approved Equal

B. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Addressable initiation devices that communicate device identity and status.
4. Control circuits for operation of mechanical equipment in response to an alarm.

C. Construction: Freestanding equipment rack or Desk-mounted console, modular, with separate and independent alarm and supervisory system modules. Alarm-initiating protected zone boards shall be plug-in cards. Arrangements that require removal of field wiring for module replacement are unacceptable.

D. Comply with UL 609, UL 1023, UL 1076.

E. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: LCD, two and three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
3. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
4. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
5. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:
    a. Acknowledge alarm.
    b. Silence alarm.
    c. System reset.
    d. LED test.
6. Timing Unit: Solid state, programmable, 365 days.
7. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
8. Alarm Indication: Audible signal sounds and an LED lights at master control unit identifying the protected zone or addressable detector originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.
9. Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone or addressable detector originating the alarm appears on LED or LCD display at master control unit. Annunciator panel displays a common alarm light and sounds an audible tone.
10. Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone or addressable detector originating the alarm appears on LED, LCD or

cathode-ray-tube display at master control unit. Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.

11. Alarm activation sounds a bell or siren and strobe.

F. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.

G. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.

H. UPS: Comply with Section 26 3353 "Static Uninterruptible Power Supply." UPS shall be sized to provide a minimum of six hours of master control-unit operation.

I. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch (25 mm) high. Identify, with permanent labels, individual components and modules within cabinets.

J. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

## 2.9 AUDIBLE AND VISUAL ALARM DEVICES

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

1. Honeywell International Inc.; Honeywell Security.
2. Tyco.
3. Owner and Consultant Approved Equal

B. Bell: Master control unit 10 inches (254 mm) in diameter, rated to produce a minimum sound output of 84 dB at 10 feet (3 m) from master control unit.

1. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

C. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet (1 m), plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on and five minutes off.

1. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

D. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet (3 m) from master control unit.

1. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

E. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.

1. Light Output: 115 cd, minimum.
2. Flash Rate: 60 per minute.

## 2.10 SECURITY FASTENERS

A. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.

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

1. Acument Global Technologies North America.
2. Safety Socket LLC.
3. Tamper-Pruf Screws.

C. Drive System Types: Pinned Torx-Plus, pinned Torx or pinned hex (Allen).

D. Socket Flat Countersunk Head Fasteners:

1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.

E. Socket Button Head Fasteners:

1. Heat-treated alloy steel, ASTM F 835 (ASTM F 835M).
2. Stainless steel, ASTM F 879 (ASTM F 879M), Group 1 CW.

F. Socket Head Cap Fasteners:

1. Heat-treated alloy steel, ASTM A 574 (ASTM A 574M).
2. Stainless steel, ASTM F 837 (ASTM F 837M), Group 1 CW.

G. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F 1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.

2. Zinc phosphate with oil, ASTM F 1137, Grade I, or black oxide unless otherwise indicated.

## PART 3 - EXECUTION

### 3.1 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 26 0548 "Vibration and Seismic Controls for Electrical Systems."

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.

2. Connect new equipment to existing monitoring equipment at the Supervising Station.

3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring] functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

E. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

### 3.2 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceways according to Section 26 0533 "Raceways and Boxes for Electrical Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring Method: Install wiring in metal raceways according to Section 26 0533 "Raceways and Boxes for Electrical Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch (13 mm). Control and data transmission wiring shall not share conduit with other building wiring systems.

C. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120-V Power Wiring: Install according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 28 0513 "Conductors and Cables for Electronic Safety and Security."
4. Data and Television Signal Transmission Cables: Install according to Section 28 0513 "Conductors and Cables for Electronic Safety and Security."

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

G. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

H. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 0553 "Identification for Electrical Systems."

## 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 26 0553 "Identification for Electrical Systems."

B. Install instructions frame in a location visible from master control unit.

## 3.4 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5 -ohm ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems."

## 3.5 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

D. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation and User training."

E. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

## 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with provisions in NFPA 731, Ch. 4, "Documentation and User training." See Section 01 7900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

**END OF SECTION**

**SECTION 28 31 11**

**DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. 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, including manual stations, detectors, signal equipment, controls, and devices. Note that this is a performance based specification. Equipment/device quantities and locations indicated are diagrammatic. Design of the fire alarm system, including device placements, selection and quantities, shall be by a NICET level III designer in accordance with the requirements of the New Mexico State Fire Marshall's Office. The design shall be approved by the New Mexico State Fire Marshall's Office. Refer to additional submission requirements below.

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

1. Division 21 Sprinkler Systems for coordinating flow, pressure, and valve tamper switch requirements.

1.3 DEFINITION

A. FACP: Fire Alarm Control Panel.

1.4 SYSTEM DESCRIPTION

A. General: Zoned, noncoded, addressable, microprocessor-based fire-detection and alarm system with manual and automatic alarm initiation, analog addressable smoke detectors, and automatic alarm verification for alarms initiated by certain smoke detector zones as indicated, horn notification.

B. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.

C. Audible Alarm Indication: By sounding of horns.

1. Per NMSU Main Campus requirements, the basic requirement is to install a horn/strobe in every occupied room, regardless of the noise level.

D. Visual Alarm Indication: By ADA compliant xenon-strobe-type units.

E. System connections for alarm-initiating and alarm-indicating circuits. Class B wiring.

1.5 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each type of system component specified including dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and Nationally Recognized Testing Laboratory (NRTL)-listing data.

C. Shop Drawings showing details of graphic annunciator (if included in project).

D. Wiring Diagrams from manufacturer differentiating clearly between factory- and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Make all diagrams specific to this Project and distinguish between field and factory wiring.

E. Floor Plans: Indicate final outlet locations and routings of raceway connections. Plans to include but not be limited to the following:

1. Detection devices
2. Notification devices
3. Panels\equipment cabinets
4. Remote indicating lights
5. Remote test stations

F. Matrix of sequence of operation.

G. Device Address List: Coordinate with final system programming.

H. System operation description covering this specific Project, including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are unacceptable. Complete riser/1-line diagram indicating all devices and interconnections.

I. Operating instructions for mounting at the FACP.

J. Product certificates signed by manufacturers of fire alarm system components certifying that their products comply with specified requirements.

K. Maintenance data for fire alarm systems to include in the operation and maintenance manual specified in Division 1. Include data for each type of product, including all features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at the site. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.

L. Submission to Authorities Having Jurisdiction: In addition to routine submission of the above

material, make an identical submission to the authorities having jurisdiction. Shop drawing submission to the Texas State Fire Marshall shall meet all requirements stated in the Texas State Fire Marshall's Office Plans Review Submittal Requirements and Information publication. Include Professional Engineer's seal, and design by a NICET Level III technician as part of the preparation and submission of the shop drawings. Upon receipt of comments from the authorities having jurisdiction, submit them for review. Resubmit if required to make clarifications or revisions to obtain approval. Do not proceed with any work prior to approval from the Texas State Fire Marshall's Office.

M. Record of field tests of system.

N. Battery and voltage drop calculations.

O. Sound pressure level calculations and intelligibility calculations for all spaces in the building.

## 1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced factory-authorized Installer to perform work of this Section.

B. Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility of system components.

C. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the authorities having jurisdiction.

D. Comply with NFPA 70.

E. Comply with NFPA 72.

F. Listing and Labeling: Provide fire alarm systems and components specified in this Section that are listed and labeled by Factory Mutual.

## 1.7 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

1. Glass Rods for Manual Stations: Quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
2. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of the number of units installed, but not less than 1.
3. Lamps for Strobe Units: Quantity equal to 10 percent of the number of units installed, but not less than 1.
4. Smoke Detectors, and Fire Detectors: Quantity equal to 10 percent of the number of units of each type installed, but not less than 1 of each type.
5. Audible, audible\strobe and strobe units: Quantity equal to 10 percent of the number of units of each type installed, but not less than 5 of each type.

6. Detector Bases: Quantity equal to 2 percent of the number of units of each type installed, but not less than 1 of each type.

## 1.8 ADDITIONAL WORK

A. In addition to quantities indicated on floor plans, include the following in the work:

1. Provide and installing **(5)** two additional of each of the following: smoke detectors, pull stations, control relay modules, audible/strobe units, strobe only, audible/strobe and audible only units. These units are to be installed at direction of the Architect in field during construction. Allow for complete installation including conduit, wire and system capacity.

2. Include an allowance of $10,000 for additional contractor furnished fire alarm signals beyond those required by the documents or approved shop drawings. The installation will occur after initial testing and in areas where signals cannot be heard properly.

3. The system's capacity and battery system will be sized to accommodate the extra (20%) devices.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

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

1. Cerberus Pyrotronics; Cerberus Technologies, Inc. Div.
2. Edwards Systems Technology; General Signal Unit
3. Federal Signal Corp.
4. Fire Control Instruments, Inc.
5. Fire Lite Alarms, Inc.
6. Notifier; Pitway Corp. Div.
7. Simplex Time Recorder Co.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Include the following system functions and operating features plus those additional functions and features required by the authorities having jurisdiction:

1. Priority of Signals: Accomplish automatic response functions by the first zone initiated. Alarm functions resulting from initiation by the first zone are not altered by subsequent alarms. The highest priority is an alarm signal. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even though the lower-priority condition occurred first. Annunciate all alarm signals regardless of priority or order received.
2. Noninterfering: Zone, power, wire, and supervise the system so a signal on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. Systems that require batteries or battery back-up for the programming function are unacceptable.
3. Fire Alarm Control Panel (FACP) Response: The manual or automatic operation of an alarm-initiating or supervisory-operating device causes the FACP to transmit an appropriate signal including the following:

    a. General alarm.
    b. Fire-suppression system operation alarm.
    c. Smoke or heat detector alarm.
    d. Valve tamper supervisory.
    e. System trouble.
    f. Fan shutdown.

4. Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service.
5. Silencing at the FACP: Switches provide capability for acknowledgment of alarm, supervisory, trouble, and other specified signals at the FACP; and capability to silence the local audible signal and light a light-emitting diode (LED). Subsequent zone alarms cause the audible signal to sound again until silenced by switch operation. Restoring alarm, supervisory and trouble conditions to normal extinguishes the associated LED and causes the audible signal to sound again until restoration is acknowledged by switch operation.
6. Loss of primary power at the FACP sounds a trouble signal at the FACP and the annunciator. An emergency power light is illuminated at both locations when the system is operating on an alternate power supply.
7. Annunciation: Manual and automatic operation of alarm- and supervisory-initiating devices is annunciated both on the FACP and on the annunciator, indicating location and type of device.
8. FACP Alphanumeric Display: Displays plain-English-language descriptions and addresses of initiating devices, alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.
9. General Alarm: A system general alarm includes the following:

    a. Indicating the general alarm condition at the FACP and the annunciator.
    b. Identifying the device that is the source of the alarm (or its zone) at the FACP and the annunciator.
    c. Initiating audible alarms and visible alarm signals throughout the building.

d. Stopping supply and return fans serving zone where alarm is initiated.
e. Closing smoke dampers on system serving zone where alarm is initiated.
f. Unlocking designated doors.
g. Recording the event on the system.
h. Initiating transmission of alarm signal to remote central station.

10. Manual station alarm operation initiates a general alarm.
11. Water-flow alarm switch operation:

a. Initiates a general alarm.
b. Causes flashing of the device location-indicating lamp for the device that has operated.

12. Smoke detection initiates a general alarm.
13. Sprinkler valve tamper switch operation causes or initiates the following:

a. A supervisory, audible, and visible "valve tamper" signal indication at the FACP and the annunciator.
b. The location-indicating light to flash for the device that has operated.
c. A printed record of the event on the system printer.
d. Transmission of supervisory signal to remote central station.

14. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP causes the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. The same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity adjustment schedule changes are recorded by the system printer.

B. Recording of Events: Print a record for all alarm, supervisory, and trouble events on the system printer. Printouts are by zone, device, and function. When the FACP receives a signal, the alarm, supervisory, and trouble conditions are printed. The printout includes the type of signal (alarm, supervisory, or trouble) the zone identification, date, and the time of the occurrence. The printout differentiates alarm signals from all other printed indications. When the system is reset, this event is also printed, including the same information for device, location, date, and time. A command initiates the printout of a list of existing alarm, supervisory, and trouble conditions in the system.

1. Permissible Signal Time Elapse: The maximum permissible elapsed time between the actuation of any fire alarm or fire-detection system alarm-initiating device and its indication at the FACP is two (2) seconds.
2. Independent System Monitoring: Supervise each independent smoke- or heat-detection system and duct detector system for both normal operation and trouble.
3. Circuit Supervision: Indicate circuit faults by both a zone and a trouble signal at the FACP. Provide a distinctive indicating audible tone and LED-indicating light. The maximum permissible elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds.

## 2.3 ADDRESSABLE DEVICES

A. Alarm-Initiating Devices: Classified as addressable devices according to NFPA 72.

1. Communication Transmitter and Receiver: Integral to device. Provides each device with a unique identification and capability for status reporting to the FACP.

## 2.4 MANUAL PULL STATIONS

A. Description: Double-action type, fabricated of metal or plastic, and finished in red with molded, raised-letter operating instructions of contrasting color.

1. Break-Glass Feature: Stations requiring the breaking of a glass panel are unacceptable. Stations requiring the breaking of a concealed glass rod are acceptable.
2. Station Reset: Key or wrench operated, double pole, double throw, switch rated for the voltage and current at which it operates. Stations have screw terminals for connections.

## 2.5 SMOKE DETECTORS

A. General: Comply with UL 268. Include the following features:

1. Factory Nameplate: Serial number and type identification.
2. Operating Voltage: 24-V dc, nominal.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
4. Plug-in Arrangement: Detector and associated encapsulated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. The plug connection requires no springs for secure mounting and contact maintenance. Terminals in the fixed base accept building wiring.
5. Integral Visual Indicating Light: Connect to indicate detector has operated.
6. Remote Controllability: Individually monitor detectors at the FACP for calibration, sensitivity, and alarm condition, and individually adjust for sensitivity from the FACP.

B. Photoelectric Smoke Detectors: Include the following features:

1. Detector Sensitivity: Between 2.5- and 3.5-percent-per-foot (0.008- and 0.011-percent-per-mm) smoke obscuration when tested according to UL 268.
2. Sensor: An infrared detector light source with matching silicon-cell receiver.

C. Duct Smoke Detector: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied.
3. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
4. Provide station with status indicator and key operated test switch.

## 2.6 OTHER DETECTORS

A. Thermal Detector: Combination fixed-temperature and rate-of-rise unit with mounting plate

arranged for outlet box mounting; 135 deg F (57 deg C) fixed-temperature setting, except as indicated.

## 2.7 ALARM-INDICATING DEVICES

A. General: Equip alarm-indicating devices for mounting as indicated. Provide terminal blocks for system connections.

B. Visual Alarm Devices: Xenon strobe lights with clear or nominal white polycarbonate lens. Mount lenses on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch (25-mm) high letters on the lens. UL Listed to Standard 1971.

1. Devices have a minimum light output of 115 candela.
2. Strobe Leads: Factory connected to screw terminals.
3. Combination devices consist of factory-combined, audible and visual alarm units in a single mounting assembly.

C. Remote Alarm Indicator: LED type, mounted flush in a single gang wall plate.

1. Connected to indicate the alarm operation of a single detector or other device.
2. Legend: "Alarm."

D. Horns:
1. Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille.
2. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
3. Mounting: Flush, semirecessed, surface, or surface-mounted bidirectional as indicated.

## 2.8 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

A. Description: An LED-indicating light in the vicinity of each device listed below, to denote the associated device is in an abnormal 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, the room where the valve is located or the protected spaces downstream from the water-flow switch.

B. Provide as follows:
1. At each sprinkler water-flow switch and valve tamper switch.
2. At each duct smoke detector (combination indicator + test station).
3. At each detector that is not readily observable from standing at floor level in a finished space.

## 2.9 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Electromagnet operates from a 24-V ac source and requires no more than 3 W to develop 25-lbf (111-N) holding force.

B. Material and Finish: Match door hardware.

## 2.10 CENTRAL FIRE ALARM CONTROL PANEL (FACP)

A. General: Comply with UL 864.

B. Cabinet: Lockable steel enclosure. Arrange panel so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control panel, provide exactly matching modular unit enclosures. Accommodate all components and allow ample gutter space for interconnection of panels and field wiring. Identify each enclosure by an engraved, red, laminated, phenolic-resin nameplate. Lettering on the enclosure's nameplate shall not be less than 1 inch (25 mm) high. Identify individual components and modules within the cabinets with permanent labels.

C. Systems: Alarm and supervisory systems are separate and independent in the FACP. The alarm-initiating zone boards in the FACP consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.

D. Control Modules: Types and capacities required to perform all functions of the fire alarm systems. Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.

E. Zones: Provide for all alarm and supervisory zones indicated.

F. Resetting: Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm or trouble condition still exists.

G. Alphanumeric Display and System Controls: Arrange to provide the basic interface between human operator at the FACP and addressable system components, including annunciation, supervision, and control. A display with a minimum of 32 characters shows alarm, supervisory and component status messages and indicates control commands to be entered into the system for control of smoke detector sensitivity and other parameters. Arrange keypad for use in entering and executing control commands.

H. Instructions: Printed or typewritten instruction card mounted behind a lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a location observable from the FACP. Include interpretation and appropriate response for displays and signals, and briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.11 SYSTEM PRINTER

A. General: Printer is dot-matrix type, listed and labeled as an integral part of the fire alarm system.

2.12 EMERGENCY POWER SUPPLY

A. General: Components include nickel-cadmium-type battery, charger, and an automatic transfer switch. Battery nominal life expectancy is 20 years, minimum.

B. Battery capacity is adequate to operate the complete alarm system in normal or supervisory (nonalarm) mode for a period of 24 hours. At the end of this period, the battery has sufficient capacity to operate the system, including alarm-indicating devices in either alarm or supervisory mode, for a period of 15 minutes.

1. Magnetic door holders are not served by emergency power. Magnetic door holders are released when normal power fails.

C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining the batteries at full charge. In the event batteries are fully discharged, the charger recharges them completely within 4 hours. Charger output is supervised as part of system power supply supervision.

D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

2.13 WIRE

A. Wire: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

2.14 UNIVERSAL DIGITAL ALARM COMMUNICATOR TRANSMITTER (UDACT)

A. Central Station Dialer. Furnish and install digital alarm dialer, which is compatible with the NMSU central station alarm reporting system, (Contact ID format).
B. Provide a UDACT at the FACP. Program, connect and configure to communicate with monitoring agency as instructed by Architect. UDACT shall be Notifier #UDACT or equal.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install system according to NFPA standards referenced in Parts 1 and 2 of this Section.

B. Fire Alarm Power Supply Disconnect: Paint red and label "FIRE ALARM." Provide with lockable handle or cover.

## 3.2 EQUIPMENT INSTALLATION

A. Manual Pull Stations: Mount semiflush in recessed back boxes with operating handles 48 inches (1220 mm) above the finished floor or lower as indicated.

B. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.

C. Smoke Detectors: Install ceiling-mounted detectors not less than 4 inches (100 mm) from a side wall to the near edge. Install detectors located on the wall at least 4 inches (100 mm), but not more than 12 inches (300 mm), below the ceiling. For exposed solid-joist construction, mount detectors on the bottom of the joists. On smooth ceilings, install detectors not over 30 feet (9 m) apart in any direction. Install detectors no closer than 60 inches (1520 mm) from air registers.

D. Audible Alarm-Indicating Devices: Install not less than 90 inches (2280 mm) above the finished floor nor less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille or as indicated. Combine audible and visual alarms at the same location into a single unit.

E. Visual Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and not more than 80 inches (2030 mm) above the finished floor and at least 6 inches (150 mm) below the ceiling.

F. Device Location-Indicating Lights: Locate in public space near the device they monitor.

G. Remote status\test station: 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.

## 3.3 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways, Boxes, and Cabinets." Conceal raceway except in unfinished spaces and as indicated.

1. All wiring installed in a metal raceway. Fire Alarm rated red MC cable acceptable in concealed locations.

B. Wiring within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. 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 visual alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

E. Wiring to Central-Station Transmitter: 1-inch (27) GRC between the FACP and the central-station transmitter connection as indicated. Install number of conductors and electrical supervision for connecting wiring as needed to suit central-station monitoring function. Final connections to terminals in central-station transmitter are made under another contract.

## 3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

## 3.5 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements of Division 26 Section "Grounding."

D. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

## 3.6 FIELD QUALITY CONTROL

A. All systems must be installed and tested per NFPA 72.

B. The entire fire alarm system shall be tested and adjusted under the supervision of a factory-trained representative of the manufacturer. Any defects will be corrected at once and the test re-conducted.

C. After the completion of the installation and supplier’s testing, the entire system, devices, wiring, and equipment will be completely tested in the presence of the architect’s representative, the NMSU Fire Department, and the facility owner. If the system fails to pass this inspection, the contractor will be liable for all additional re-inspection and re-testing expenses. NMSU Fire Department must approve the entire Fire Alarm System before it will be accepted.

D. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

E. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

F. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

G. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

H. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:

1. Verify the absence of unwanted voltages between circuit conductors and ground.
2. Test all conductors for short circuits using an insulation-testing device.
3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
   Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
7. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

I. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

J. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.

K. Tag all equipment, stations, and other components at which tests have been satisfactorily

completed.

## 3.7 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.
B. Construction Waste: In accordance with Section 01 74 19.

## 3.8 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of eight (8) hours' training.
2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
3. Schedule training with Owner with at least seven (7) days advance notice.

## 3.9 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to 3 requested adjustment visits to the site for this purpose.

END OF SECTION

# SECTION 31 0000 - EARTHWORK

## PART 1 – GENERAL

### 1.1 DESCRIPTION OF WORK

A. Extent of earthwork shall be as indicated on drawings and shall include excavation, filling, backfilling, compaction, and grading under and around structures, and as shown on plans.

1. Preparation of subgrade for building foundations, slabs and exterior walkways is included as part of this work.
2. Backfilling of trenches beyond building lines is included as part of this work.
3. Site Grading is included as part of this work.

### 1.2 DEFINITIONS

A. "Excavation" consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.

B. "Unauthorized Excavation" consists of removal of materials beyond indicated subgrade elevations or dimensions without specific instructions from the Engineer to do so.

### 1.3 REFERENCES

A. General: The documents referenced in this section are declared to be a part of these specifications, the same as if fully set forth, except modified herein. Except as specifically stated otherwise, the edition or revision of each document which is in effect at the beginning of work on this project shall be used.

B. Geotechnical Investigation:

1. Geotechnical Engineering Report: AG Modernization – NMSU's Building Geotechnical Report dated xxxx.

C. American Society for Testing and Materials (ASTM):

1. ASTM D422- Standard Test Method for Particle Size Analysis of Soils
2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
3. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2700KN-m/m3))
4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
5. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

D. Uniform Building Code (UBC):

1. Chapter 29 - Excavations, Foundations and Retaining Walls

E. New Mexico Standard Specifications for Public Works Construction, Latest Edition, including all updates, and all applicable laws, codes, and regulations.

F. New Mexico State University Engineering and Construction Design Guidelines, Rev. May 2020.

G. New Mexico State University Construction and Material Specifications, Rev. May 2011.

## 1.4 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

B. Testing and Inspection Service: The Owner shall employ a Testing Laboratory acceptable to Engineer to perform testing and inspection services for quality control testing during earthwork operations.

## 1.5 SUBMITTALS

A. Fill and Backfill Materials: Gradation and moisture-density relationship for each material proposed for use as fill or backfill.

## 1.6 JOB CONDITIONS

A. Bench Marks: Protect bench marks on or adjacent to site from damage. If bench marks are damaged, restore as required by authorities having jurisdiction.

B. Unexpected Conditions: Notify Engineer and Owner's representative of unexpected subsurface conditions. Discontinue affected work in area until notified to resume work.

C. Existing Utilities:

1. Identify existing underground utilities in areas of work located by Owner. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
2. If uncharted, or incorrectly charted, piping or other utilities are encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

D. Protection of Persons and Property:

1. Barricade open excavations occurring as part of this work and post with warning lights.
2. Operate warning lights as recommended by authorities having jurisdiction.
3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork

operations.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

A. Base Course: New Mexico American Public Works Association Standard Specifications for Public Works Construction, Section 302.

B. Structural Backfill and Fill Materials: Per Geotechnical Report

C. Pipe bedding material shall be processed natural material meeting the gradation requirements specified below. The plasticity index of the material used for pipe bedding shall not exceed 10 as determined by ASTM D4318.

| Sieve Size Square Openings by Weight | Percent Passing |
|---|---|
| 1/2” | 100 |
| No. 4 | 50 - 100 |
| No. 200 | 10 - 40 |

## PART 3 - EXECUTION

### 3.1 CLEARING AND GRUBBING:

A. General: Clearing and grubbing will be required for areas indicated on the Drawings to be excavated, improved or on which fill is to be constructed. Cleared and grubbed materials, including trash, shall be deposited to an approved disposal site.

B. Clearing: Clearing shall consist of removal and disposal of existing paving materials, concrete and vegetation as well as matted roots, brush and rubbish within the areas to be improved and constructed upon.

C. Grubbing: Stumps, matted roots and roots larger than two (2) inches in diameter shall be removed from within ten (10) inches of the surface of areas on which improvements and fills are to be constructed except in roadways. Materials as described above and which are within eighteen (18) inches of finished subgrade of roadways in either cut or fill sections shall be removed. Areas disturbed by grubbing shall be filled as specified herein for engineered fill and backfill.

D. Inspection: Cleared and excavated areas shall be inspected by Geotechnical Engineer prior to scarifying and placing fills.

A. Identify required lines, levels, contours and datum.

B. Identify known underground utilities located by Owner. Protect stakes and flags installed by Owner.

C. Identify and flag surface and aerial utilities.

D. Notify utility companies to remove or relocate utilities as necessary.

E. Maintain and protect existing utilities which pass through site.

## 3.2 EXCAVATION

A. General:

1. Excavate to subgrade elevations indicated.
2. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor's expense.

B. Additional Excavation:

1. When excavation has reached required subgrade elevations, notify Engineer who will make an inspection of conditions.
2. If unsuitable bearing materials are encountered at required subgrade elevations, notify Engineer. Do not continue excavating without specific instructions to do so from the Engineer and replace excavated material as directed by Engineer.
3. Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in work.

C. Stability of Excavations:

1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction, OSHA requirements, and as required for slope stability based on site conditions. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
2. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

D. Dewatering:

1. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations. Use methods, materials and equipment as necessary to prevent damage to existing construction.

3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

E. Material Storage:

1. Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
2. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
3. Dispose of excess soil material and waste materials off site in accordance with local codes and ordinances.

F. Excavation for Structures:

1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

G. Cold Weather Protection:

1. Protect excavation bottoms against freezing.

## 3.3 FILL AND BACKFILL

A. Begin fill and backfill operations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.
2. Inspection, testing, approval, and recording locations of underground utilities.
3. Removal of concrete formwork.
4. Removal of trash and debris.
5. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

B. Site Preparation:
1. This site shall be prepared by removing and clearing any existing foundations, paved areas, grass, trees, tree roots, and organic topsoils where indicated on the construction drawings.
2. The Subgrade shall be proof rolled to detect local weak areas which should be excavated, processed, and recompacted in loose lifts of approximately 8-inch thickness and compacted to 95% of Standard Proctor Density (ASTM D-1557).

C. Subgrade Preparation:
1. Unless specified in the geotechnical report, the top 12 inches of in-place soil shall be plowed or scarified, processed to near optimum moisture (+/-2%) and compacted to at least 95% of maximum dry density (ASTM Designation: D-1557).
2. The site shall be proof rolled to detect soft areas which should be removed and properly replaced.
3. Subgrade shall be tested by a qualified Laboratory Technician under the supervision of a Registered Professional Engineer specializing in geotechnical studies.

D. Placement:

1. All select fill material shall have a Plasticity Index nor greater than 15 and should be placed in 8-inch loose lifts and compacted with approved compaction equipment. All soil for fill shall be free of large rock (larger than 2”) or other deleterious material and shall be processed to near optimum moisture (+/-2%) and compacted to a minimum of 95% of maximum dry

density as determined by ASTM Designation D1557 and when tested in accordance with ASTM Designation: D 2922 prior to placing the next lift. The plasticity index and liquid limit of material used as select, non-expansive fill shall be routinely verified during fill placement using laboratory tests. Visual observation and classification shall not be relied upon to confirm the material to be used as select, non-expansive fill satisfies the above Atterberg-limit criteria.

2. The site shall be proof rolled to detect soft areas which should be removed and properly replaced.
3. Each lift shall be tested by a qualified Laboratory Technician under the supervision of a Registered Professional Engineer specializing in geotechnical studies.

## 3.4 GRADING

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding.

C. Finish surfaces free from irregular surface changes, and as follows:

1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations.
2. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10' above or below required subgrade elevation.

E. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum density for each area classification.

## 3.5 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

D. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

## 3.6 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Remove waste materials, including unacceptable excavated material, trash and debris, and dispose of it off Owner's property.

## 3.7 FIELD QUALITY CONTROL

A. An independent testing laboratory, selected and paid for by the Owner and approved by the Engineer, shall be retained to perform construction testing of in-place materials.
Testing and inspection shall include, but is not limited to, the following tests. Testing and inspection shall be performed by a licensed Geotechnical Engineering firm or its representative.

1. Determine maximum densities and optimum moisture contents in accordance with ASTM D-1557.
2. Determine in-place density by either the sand-cone method (ASTM D1556) or the nuclear method (ASTM D2922).

B. Test subgrade, fill materials and embankments at the following rates:

1. One field density test for each 100 square yards of subgrade.
2. One field density test for each 100 cubic yards of fill or for each fill layer, whichever results in the greater number of tests.
3. One moisture-density for each type of subgrade material encountered and each type of fill material used, as indicated by sieve analysis and plasticity index.

C. If testing results indicate that density of in-place material is less than that required, recompact and retest until requirements of this specification are met. Costs of retesting are the Contractor's expense.

D. Provide Engineer written notification 48 hours in advance of when testing will be conducted. Conduct tests in presence of Engineer or Engineer’s representative.

**END OF SECTION**

# SECTION 31 6316 - AUGER CAST GROUT PILES

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Machine augered shaft, placement of pressure injected grout and internal reinforcement.

### 1.2 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Requirements for concrete.

### 1.3 SUBSURFACE SOIL DATA

A. Subsurface soil investigations have been made and the results are available for examination by the Contractor. The Contractor shall examine the site and determine the character of materials to be encountered prior to proceeding with the work.

### 1.4 REFERENCE STANDARDS

A. ASTM C33/C33M - Standard Specification for Concrete Aggregates.

B. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens); 2020.

C. ASTM C150/C150M - Standard Specification for Portland Cement.

D. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

E. ASTM C937 - Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.

### 1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Grout mix design and performance history, in compliance with Section 03 3000 of these Specifications.

C. Reinforcing shop drawings.

D. Pier bar locator accessories data sheets.

E. Designer's Qualification Statement.

F. Installer's Qualification Statement.

G. Project Record Documents: Record actual locations of piles, pile diameter, and pile length. Accurately record the following on project record documents:

1. Sizes, lengths, and locations of piles and footing groups.
2. Sequence of placement.
3. Final base and top elevations.
4. Deviation from indicated locations.
5. Placement and configuration of reinforcement.
6. Location and type of casings, if used.

## 1.6 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of type specified in this section with at least five years of documented experience.

B. The entire pile installation operation shall be under the full-time observation of an experienced engineering technician working under the supervision of a registered Professional Geotechnical Engineer. This observation shall be in compliance with, and serve as, the “Special Inspections” described on the drawings and per the 2021 International Building Code, Chapter 17.

# PART 2 PRODUCTS

## 2.1 MATERIALS

A. Concrete Grout Materials and Mix: Specified in Section 03 3000. And as indicated on drawings.

B. Reinforcement: Specified in 03 3000; spiral wound.

C. Reinforcement Accessories: Basis of Design: Pieresearch Pier Wheels, Pier Boots, and Centralizer accessories.

# PART 3 EXECUTION

## 3.1 PREPARATION

A. Use placement method that will not cause damage to nearby structures.

B. Protect structures near the Work from damage.

C. Prepare to place piles from excavated working elevation. Do not begin installation until ground elevation at each pile location is at least 12 inches higher than required pile cutoff elevation.

## 3.2 INSTALLATION

A. Progressively raise auger and simultaneously pressure inject concrete grout with equipment designed for such placement. Place grout in accordance with provisions of Section 03 3000.

B. Except where otherwise specifically directed by supervising engineer, drill each pile hole and fill with grout in an uninterrupted operation.

C. Provide reinforcement locators as required to maintain required clearances.

D. Prepare pile top to receive pile cap

E. Extend reinforcement for connection of caps.

## 3.3 TOLERANCES

A. Maximum Variation From Vertical: 1 in 48.

B. Maximum Variation From Design Top Elevation: 4 inches.

C. Maximum Out-of-Position: 2 inches.

## 3.4 FIELD QUALITY CONTROL

A. Perform field inspection and testing according to provisions of Section 01 4000 - Quality Requirements.

## 3.5 UNACCEPTABLE PILES

A. Unacceptable Piles: Piles that fail, are placed out of position, are below elevations, or are damaged.

B. Provide additional piles or replace footings failing to comply with specified requirements.

**END OF SECTION**

# SECTION 32 1200 - FLEXIBLE PAVING

## PART 1 – GENERAL

### 1.1 RELATED REQUIREMENTS:

A. Any New Mexico Standard Specifications for Public Works Construction sections referred to or noted on the drawings which pertain to flexible paving design, materials, preparation, and/or execution of this product shall supersede this section. All materials shall be as indicated on Drawings and shall comply with applicable New Mexico Standard Specifications for Public Works Construction regarding source, quality, gradation, and mix design proportioning.

### 1.2 SUBMITTALS

A. Design Mix: Before any asphalt concrete paving is constructed, submit actual design mix to the Engineer for review and/or approval. Design mix submittal shall follow the format as indicated in the New Mexico Standard Specifications for Public Works Construction, Latest Edition.

B. Material Certificates: Submit materials certificate to onsite independent testing laboratory which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein.

### 1.3 JOB CONDITIONS

A. Weather Limitations

1. Apply prime and tack coats when ambient temperature is above 40°, and when temperature has been above 35° for 12 hours immediately prior to application. Do not apply when subgrade is wet or contains excess moisture.
2. Construct asphalt concrete paving when atmospheric temperature is above 40°.

### 1.4 REFERENCES

A. New Mexico State University Engineering and Construction Design Guidelines, Rev. May 2020.

B. New Mexico State University Construction and Material Specifications, Rev. May 2011.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Provide asphalt-aggregate mixture as recommended by local or state paving authorities to suit project conditions. Use locally available materials and gradations which meet New Mexico

Standard Specifications for Public Works Construction, Geotechnical Investigation Recommendations, and exhibit satisfactory record on previous installations.

B. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with AASHTO M-17/ASTM D 242, if recommended by applicable New Mexico standards.

C. Asphalt Cement: Comply with AASHTO M-226/ASTM D 3381; AC-20, AR-80, viscosity grade.

D. Tack Coat: Emulsified asphalt; AASHTO M-140/ASTM D 997 or M 208/ASTM D 2397, SS-1h, CSS-1, or Css-1h, diluted with one part water to one part emulsified asphalt.

E. Aggregate Base Course & Asphaltic Concrete: per New Mexico Standard Specifications for Public Works Construction and Geotechnical Investigation.

F. To meet the LEED Requirements, all products are to be free of Coal Tar Sealants.

## 2.2 EQUIPMENT

Maintain equipment in satisfactory operating condition and correct breakdowns in a manner that will not delay or be detrimental to progress of paving operations.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Remove loose material from compacted base material surface immediately before applying prime coat.

B. Proof roll prepared base material surface to check for unstable areas and areas requiring additional compaction.

C. Do not begin paving work until deficient base material areas have been corrected and are ready to receive paving.

## 3.2 APPLICATIONS

A. Prime Coat

1. Apply bituminous prime coat to all base material surfaces where asphalt concrete paving will be constructed.
2. Apply bituminous prime coat in accordance with New Mexico Standard Specifications for Public Works Construction, Section 307.
3. Apply at minimum rate of 0.1 to 0.3 gallons per square yard over compacted base material. Apply to penetrate and seal, but not flood surface.
4. Make necessary precautions to protect adjacent areas from over-spray.

5. Cure and dry as long as necessary to attain penetration and evaporation of volatile components.

B. Tack Coat

1. Apply tack coat to contact surfaces of previously constructed asphalt concrete base courses or Portland cement concrete and surfaces abutting or projecting into asphalt concrete and surfaces abutting or projecting into asphalt concrete pavement.
2. Apply tack coat to asphalt concrete base course or sand asphalt base course. Apply emulsified asphalt tack coat between each lift or layer of full depth asphalt concrete and sand asphalt bases and on surface of all such bases where asphalt concrete paving will be constructed.
3. Apply emulsified asphalt tack coat in accordance with New Mexico Standard Specifications for Public Works Construction, Section 336.
4. Apply at minimum rate of 0.03 to 0.12 gallon per square yard of surface.
5. Allow to dry until at proper condition to receive paving.

## 3.3 ASPHALTIC CONCRETE PLACEMENT

A. Place asphalt concrete mixture on completed compacted subgrade surface, spread, and strike off. Spread mixture at following minimum temperatures:

1. When ambient temperature is between 40° F and 50° F: 285° F.
2. When ambient temperature is between 50° F and 60° F: 280° F.
3. When ambient temperature is higher than 60° F: 275° F.

B. Place inaccessible and small areas by hand. Place each course to required grade, cross-section, and compacted thickness.

C. Paving Machine Placement: Apply successive lifts of asphalt concrete in transverse directions with the surface course placed in the direction of surface-water flow. Place in typical strips not less than 10' - 0" wide.

D. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

E. Asphalt Concrete Curbs: Construct asphalt curbs over compacted pavement surfaces only when indicated on Drawings. Apply light tack coat unless pavement surface is still tacky and free from dust. Place curb materials to cross-section indicated by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms as soon as material has cooled.

## 3.4 ROLLING AND COMPACTION

A. The mixture, after being spread, shall be thoroughly compacted by rolling as soon as it will bear the weight of the rollers without undue displacement. The number, weight, and types of rollers

and sequences of rolling operations shall be such that the required density and surface are consistently attained while the mixture is in a workable condition.

B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.

D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

## 3.5 FIELD QUALITY CONTROL

A. Independent Testing Laboratory, selected and paid by the Owner, shall be retained to perform construction testing of in-place asphalt concrete courses for compliance with requirements for density. Testing shall be in accordance with ASTM D-2922.

B. Grade Control: Establish and maintain required lines and elevations.

C. Surface Smoothness: Testing shall be performed on the finished surface of each asphalt concrete course for smoothness, using 10' - 0" straightedge applied parallel with, and at right angles to centerline of paved area. The results of these tests shall be made available to the owner upon request. Surfaces will not be acceptable if exceeding following tolerances for smoothness:

Subgrade: 1/2"
Wearing Course Surface: 3/16"

D. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner.

**END OF SECTION**

# SECTION 32 1300 - CONCRETE PAVEMENT, CURB AND SIDEWALKS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes all portland concrete pavement outside the building limits, including but not limited to:

1. Driveways and roadways
2. Parking lots
3. Curbs and gutters
4. Sidewalks

B. For concrete located within the building limits: refer to Section 03 3000 – Cast-In- Place Concrete

### 1.2 REFERENCES

A. American Society of Testing Materials (ASTM)

1. A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
2. A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
3. A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
4. C33 - Standard Specification for Concrete Aggregates
5. C94 - Standard Specification for Ready-Mixed Concrete
6. C150 - Standard Specification for Portland cement
7. C171 - Standard Specification for Sheet Materials for Curing Concrete
8. C260 - Standard Specification for Air-Entraining Admixtures for Concrete
9. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
10. C494/C494M - Standard Specification for Chemical Admixtures for Concrete
11. 1C979 - Standard Specification for Pigments for Integrally Colored Concrete

12. 1C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete

13. 1D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

14. 1D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

15. 1D3405 - Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements

16. 1D5249 - Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

17. 1D5893 - Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

B. American Concrete Institute (ACI)

1. 301R-99 – Specifications for Structural Concrete

2. 304R – Placing and Handling Concrete, etc.

3. 309R-96 – Guide for Consolidating of Concrete

4. 330.1 – Standard Specifications for Plain Concrete Parking Lots

5. 330.2R-17 – Guide for the Design and Construction of Concrete Site Paving for Industrial and Trucking Facilities.

6. 330R-08 – Guide for Design & Construction of Concrete Parking Lots

7. 211R-91 – Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete

C. American Association of State Highway and Transportation Officials (AASHTO)

1. M182 – Standard Specifications for Burlap Cloth made from Jute for Kenaf

2. M153 – Standard Specifications for Preformed Sponge Rubber and Cork Expansion Joint Filler

D. New Mexico State University Engineering and Construction Design Guidelines, Rev. May 2020.

E. New Mexico State University Construction and Material Specifications, Rev. May 2011.

## 1.3 SUBMITTALS

A. Mix Design: For each concrete mix to be utilized.

B. Material certificates and test reports.

C. The General Contractor and the Subcontractor shall execute the Conformance Submittal(s) at the end of this section.

## PART 2 - PRODUCTS

### 2.1 STEEL REINFORCEMENT

A. The type of steel reinforcement shall be as shown on the drawings.

1. Plain-Steel Welded Wire Fabric: ASTM A 185, 6inches x 6inches #10 mesh fabricated from steel wire into flat sheets;

2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed;

3. Plain Steel Wire: ASTM A 82, as drawn; and,

4. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening steel reinforcement. Manufacture bar supports according to CRSI's Manual of Standard Practice.

5. Diamond Dowels: ⅜” x 4 ½” Diamond Dowels by PNA

### 2.2 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I, II or III.

B. Aggregate: ASTM C 3 Combined aggregate gradation for concrete pavement and other designated concrete shall be 8% - 18% for large top size aggregates (1½”) or 8% - 22% for smaller top size aggregates (1” or ¾”) retained on each sieve below the top size and above the No. 100 sieve. Concrete pavements shall have a maximum aggregate size of 1½”.

C. Water/Ready Mix Concrete: ASTM C 9

D. Admixtures: Certified by manufacturer to contain not more than 0.1 % water-soluble chloride ions by mass of cement and to be compatible with other admixtures, as follows:

1. Air-Entraining Admixture: ASTM C 260;

2. Water-Reducing Admixture: ASTM C 494, Type A;

3. Water-Reducing and High-Range Admixture: ASTM C 494, Type F;

4. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E; and,

5. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

E. Calcium Chloride: The use of calcium chloride or admixtures containing more than 0.05% chloride ions is prohibited.

F. Curing Materials:

1. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry;

2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet;

3. Water: Potable;

4. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete;

5. Clear Solvent-Borne Liquid-Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B;

6. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B;

7. White Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B.

## 2.3 CONCRETE MIXES AND MIXING

A. Concrete Mixes: Prepare design mixes, proportioned according to ACI 211R-91 and ACI 304, with the following properties:

1. Compressive Strength (28 Days): 4,000 psi, except as noted on the drawings;

2. Slump Limit: maximum of 5 inches at time of placement for pavement, 2 inch maximum for curb and sidewalk;

3. Air Content: 5% to 8% for pavement, curb and sidewalk.

4. Maximum water-cementitious ratio – 0.48

B. Coloring Agent: When required, add coloring agent to mix according to manufacturer's written instructions.

1. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork; and,

2. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.

C. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94 and ASTM C 111

D. Project-Site Mixing: On-site mixing must be approved by the Owner. Comply with requirements and measure, batch, and mix concrete materials and concrete according to ASTM C 9 Mix concrete materials in appropriate drum-type batch machine mixer.

## 2.4 JOINTS, FILLERS, AND SEALANTS

A. Joint-Sealant Backer Materials: ASTM D5249, Non-Staining, compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.

B. Joint Sealant: Non-priming, pourable self-leveling silicone sealant for concrete and asphalt.

1. Cold-Applied Joint Sealant ASTM D5893, self-leveling silicone sealant. Crafco, Inc. "Roadwaver Silicone-SL"; Dow Corning "888, or 890-SL"; Sonneborn "Sonomeric 1 Sealant"; Tremco "Vulkem 45"; and,

2. Hot-Applied Joint Sealant: ASTM D3405, Polymeric sealant. Crafco Inc. "ROADSAVER 22"; W.R. Meadows, Inc. "SEALTIGHT HI-SPEC".

C. Joint Fillers: Resilient pre-molded bituminous impregnated fiberboard units complying with ASTM D 1751, asphalt-saturated cellulosic fiber, ASSHTO M 153, Type I: or ASTM D 1752, cork or self-expanding cork.

D. Exterior Concrete Sealant: Sonneborn "Kure-N-Seal 30" exterior acrylic sealer, or Euclid "Super Rez-Seal".

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Surface Preparation: Proof roll prepared subbase, per Section 31 00 00 and the geotechnical report- Earthwork and remove loose material from surface.

B. Forms: Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations, per Section 02010, Project Survey, and Layout.

1. Maintain sufficient quantity of forms to allow continuance of work so that forms remain in place a minimum of 24 hours after concrete placement;

2. Forms shall be cleaned and casted with form release agent thoroughly after each use and before concrete is placed; and,

3. Flexible or curved forms shall be used on curves. Forms shall be of full depth of the concrete and of a strength when staked, sufficient to resist the presence of the concrete and the loads resulting from the finish operations without springing, setting or losing their shape.

C. Reinforcement: Accurately position and support reinforcement, and secure against displacement. Set wire ties with ends directly into concrete.

1. Install welded wire fabric in lengths as long as practicable; lap at least one full mesh, and lace splices with wire; and,

2. Support reinforcing steel on wire chairs to ensure that wire stays mid-depth of sidewalk section during concrete pour.

D. Joints: Construct pre-molded expansion and contraction joints, tied construction joints, control joints, thickened edge expansion joints, isolation joints, and construction joints, straight with face perpendicular to concrete surface. Construct transverse joints perpendicular to centerline unless otherwise detailed.

1. Expansion joints and Contraction joints: Pre-molded as indicated on the drawings;

   a. Provide joint filler for the entire depth of the slab section and not less than 1inch below finished surface so as to allow for joint sealer.

   b. Provide thickened edge expansion joint as indicated on the drawings.

   c. Provide 1/2-inch contraction joints for curb and gutter at 5 feet on center.

   d. Provide 1/2-inch expansion joints for curb and gutter and sidewalk at 30 feet on center.

2. Tied construction joints: As indicated on drawings;

3. Control joints: Depth shall be equal to ¼ of the concrete thickness or 1 inch, whichever is deeper.

   a. For sidewalks, control joint spacing shall be equal to the sidewalk width.

   b. For concrete pavement, control joint spacing shall be placed as shown on the drawings, no greater than 30 times the slab thickness on center either way;

   c. Form tooled joints in fresh concrete by grooving top portion with recommended tool and finishing edges with jointer.

   d. Form sawed joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete within 24 hours of the concrete placement and as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.

4. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for period of more than ½ hour, except where such placements terminate at expansion joints. Provide ⅜” x 4½” Diamond Dowels by PNA at 24” on center or as shown on the drawings;

5. Isolation Joints: Locate isolation joints as indicated on the drawings. Provide pre-molded joint filler for catch basins, manholes, inlets, structures, walks, light pole bases and other fixed objects;

6. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than ½inch or more than 1 inch below finished surface where joint sealer is indicated. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together; and,

7. Joint Sealants: All joints shall be sealed with approved exterior pavement joint sealants and shall be installed per manufacturer's recommendations.

E. Concrete Placement: Comply with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete. Place concrete in a continuous operation within planned joints or sections.

1. Moisten subbase to provide a uniform dampened condition at time concrete is placed;

2. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping according to recommendations in ACI 309R;

3. Screed and initial-float concrete surfaces with darby or bull float before excess moisture or bleed water appears on the surface;

4. Protect concrete from cold or hot weather during mixing, placing, and curing; and,

5. All concrete walks and aprons shall be a minimum of 4 inches thick as shown on the drawings, with a turned down edge as detailed.

F. Evaporation Retarder: Apply to concrete surfaces if hot, dry, or windy conditions exist. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

G. Pavement Tolerances: Comply with tolerances in ACI 330.1, Specification for Plain Concrete Parking Lots.

## 3.2 FINISHES AND CURING

A. All exterior concrete shall receive a medium broom finish.

B. Curing: Begin curing after finishing concrete, but not before free water has disappeared from concrete surface. Cure concrete by one or a combination of the following methods:
1. Moisture cure concrete by water, continuous fog spray, continuously wet absorptive cover, or by moisture-retaining-cover curing. Keep surfaces continuously moist for not less than 7 days; and,
2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

C. All exterior concrete surfaces shall receive one coat of exterior sealer.

## 3.3 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Protect concrete from damage. Provide adequate traffic control to prevent traffic from pavement for at least 14 days after placement.

C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than 2 days before date scheduled for substantial completion inspections.

## 3.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301R-99 and ACI330R-92, unless modified by the requirements of the Contract Documents.

C. The owner shall provide and pay for testing services. A slump test and air test shall be performed for each load delivered. Four standard test cylinders shall be taken for each 55 cubic yards of concrete or each day's pour, whichever is more frequent. Two cylinders shall be broken at 7 days and two cylinders shall be broken at 28 days.

**END OF SECTION**

# SECTION 32 1723.13 - PAVEMENT MARKINGS

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Parking lot markings, including parking bays, crosswalks, arrows, accessibility symbols, and curb markings.

B. Roadway lane markings and crosswalk markings.

C. "No Parking" curb painting.

### 1.2 RELATED REQUIREMENTS

A. Section 32 1216 - Asphalt Paving.

B. Section 32 1313 - Concrete Paving.

### 1.3 REFERENCE STANDARDS

A. FS TT-B-1325 - Beads (Glass Spheres); Retro-Reflective.

B. FS TT-P-1952 - Paint, Traffic Black, and Airfield Marking, Waterborne.

C. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association.

D. FHWA MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways; U.S. Department of Transportation, Federal Highway Administration.

### 1.4 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.

B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment accompanied by batch certificate.

C. Store products in manufacturer's unopened packaging until ready for installation.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

### 1.6 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

## PART 2 PRODUCTS

### 2.1 MATERIALS

A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.

1. Roadway Markings: As required by authorities having jurisdiction.
2. Fire Lanes: As noted on the drawings.
3. Parking Stall Striping: White.
4. Accessibility Symbols: Blue and white, as noted on the drawings.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Reflective Glass Beads: FS TT-B-1325, Type I (low index of refraction), Gradation A (coarse, drop-on); with silicone or other suitable waterproofing coating to ensure free flow.

C. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

## PART 3 EXECUTION

### 3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

## 3.2 PREPARATION

A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

B. Obliteration of existing markings using paint is acceptable in lieu of removal; apply the black paint in as many coats as necessary to completely obliterate the existing markings.

C. Clean surfaces thoroughly prior to installation.

1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.

D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.

F. Temporary Pavement Markings: When required or directed by Architect, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.

1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.

2. At Contractor's option, temporary marking tape may used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.

## 3.3 INSTALLATION

A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.

B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.

E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.

1. Apply paint in one coat only.
2. Wet Film Thickness: 0.015 inch, minimum.
3. Width Tolerance: Plus or minus 1/8 inch.

G. Roadway Traffic Lanes: Use suitable mobile mechanical equipment that provides constant agitation of paint and travels at controlled speeds.

1. Conduct operations in such a manner that necessary traffic can move without hindrance.
2. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.
3. If paint does not dry within expected time, discontinue paint operations until cause of slow drying is determined and corrected.
4. Skip Markings: Synchronize one or more paint "guns" to automatically begin and cut off paint flow; make length of intervals as indicated.
5. Use hand application by pneumatic spray for application of paint in areas where a mobile paint applicator cannot be used.
6. Distribute glass beads uniformly on the paint lines within ten seconds without any waste, applied at rate of 6 pounds per gallon of paint; if the marking equipment does not have a glass bead dispenser, use a separate piece of equipment adjusted and synchronized with the paint applicator; remove and replace markings having faulty distribution of beads.

H. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.

1. Mark the International Symbol of Accessibility at indicated parking spaces.
2. Hand application by pneumatic spray is acceptable.

I. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

## 3.4 DRYING, PROTECTION, AND REPLACEMENT

A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.

B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.

C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.

D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.

F. Replace removed markings at no additional cost to Owner.

**END OF SECTION**

# SECTION 32 3300 - SITE FURNISHINGS

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Benches.

B. Bollards.

C. Tables.

D. Waste receptacles.

### 1.2 RELATED REQUIREMENTS

A. Division 05: Miscellaneous metal for metal anchors.

B. Division 32: Concrete pavement and cast-in-place concrete.

### 1.3 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

D. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

E. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

F. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire.

### 1.4 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's specifications and descriptive literature, installation instructions, and maintenance information.

C. Shop Drawings: Indicate plans for each unit or groups of units, elevations with model number, overall dimensions; construction, and anchorage details.

D. Samples: Submit two sets of manufacturer's available colors for metal furnishings.

## 1.5 SUBSTITUTIONS

A. See Section 01 6000 - Product Requirements, for substitution procedures.

## 1.6 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

# PART 2 PRODUCTS

## 2.1 MANUFACTURERS

A. Metal Furnishings:

1. DuMor: www.dumor.com
2. Tournesol Siteworks: www.tournesol.com.

## 2.2 METAL FURNISHINGS

A. Metal Furnishings, General:

1. Steel components: Plates, bars, and shapes complying with ASTM A36/A36M and tubing complying with ASTM A500/A500M; cleaned, treated, and powder-coated.
   a. Color: As selected by Architect from manufacturer's standard range.
2. Hardware: Stainless steel.

B. Benches: Metal frame and seat section with back.

1. Frame: _____.
2. Seat: Wood slat.

C. Bench

1. Basis of Design: DuMor Bench 500-60HS as manufactured by DuMor.
2. Steel finish: powdercoat, color TBD.

D. Tables: Steel

1. Basis of design: DuMor TAbles 294 product numbers- 294- 40HS and 294 39HS as manufactured by DuMor. ww.dumor.com

2. Configuration: Tables and chairs.
3. Seating: Compliant with ADA Standards.
4. Shape: Round.
5. Mounting: Surface, using concealed anchor rods.

E. Waste Receptacles: Steel frame with steel slats and fixed lid and hinged side-opening door.
1. Basis of Design: DuMor Recpetacle 502 as manufactured by DuMor. www.Dumor.com
2. Capacity: 32 gallons.
3. Shape: Square.
4. Length: 16 inches.
5. Width: 20 inches.
6. Height: 46 inches.
7. Inserts: Removable plastic containers for waste material.
8. Mounting: Surface.
9. Products:
a. DuMor: www.Dumor.com.

## 2.3 BOLLARDS

A. Steel Pipe Bollards: Hollow steel pipe with plain shaft.
1. Shape: Round.
2. Diameter: ____ inches.
3. Materials:
a. Steel Pipe: ASTM A53/A53M, standard weight.
b. Factory Finish: Primed.
4. Mounting: In-ground.

# PART 3 EXECUTION

## 3.1 EXAMINATION

A. Verify that mounting surfaces, preinstalled anchor bolts, or other mounting devices are properly installed; and ready to receive site furnishing items.

B. Do not begin installation until unacceptable conditions are corrected.

## 3.2 INSTALLATION

A. Install site furnishings in accordance with approved shop drawings, and manufacturer's installation instructions.

B. Provide level mounting surfaces for site furnishing items.

**END OF SECTION**

# SECTION 32 3313 - SITE BICYCLE RACKS

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Exterior bicycle racks.

### 1.2 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Mounting surface for bicycle racks.

B. Section 05 5000 - Metal Fabrications: Custom metal outdoor furnishings.

### 1.3 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

C. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

### 1.4 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Shop Drawings: Indicate size, shape, and dimensions, including clearances from adjacent walls, doors, and obstructions.

D. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.

### 1.5 SUBSTITUTIONS

A. See Section 01 6000 - Product Requirements, for submittals.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Handle racks with sufficient care to prevent scratches and other damage to the finish.

## 1.7 WARRANTY

A. See Section 01 7800 - Closeout Submittals.

B. Provide manufacturer’s limited warranty against defects in materials or workmanship for a minimum period of 10 years from Date of Substantial Completion.

# PART 2 PRODUCTS

## 2.1 MANUFACTURERS

A. Exterior Bicycle Racks:

## 2.2 BICYCLE RACKS

A. Exterior Bicycle Racks: Device allows user-provided lock to simultaneously secure one wheel and part of the frame on each bicycle parked or racked.

1. Style: Coil.
2. Capacity: Seven bicycles.
3. Mounting, Ground: In-ground anchor.
4. Finish: Powder coat, maintenance-free and weather-resistant.
5. Color: As selected by Architect from manufacturer's standard range.
6. Accessories: In-ground grout cover.

B. Materials:

1. Pipe: Carbon steel, ASTM A53/A53M, Schedule 40.
2. Tube: Carbon steel, ASTM A500/A500M.
3. Bar, Round and Flat, Carbon Steel: ASTM A36/A36M.

## PART 3 EXECUTION

### 3.1 EXAMINATION

A. Examine surfaces to receive bicycle racks.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory conditions before proceeding.

C. Do not begin installation until unsatisfactory conditions are corrected.

### 3.2 PREPARATION

A. Ensure surfaces to receive bicycle racks are clean, flat, and level.

### 3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install level, plumb, square, and correctly located as indicated on drawings.

C. In-Ground Anchor Installation:

1. Prepare holes in size according to manufacturer’s instructions.
2. Place anchoring bolts through the holes in pipe.
3. Lower rack into holes, ensuring the bottom of lower bends are at least 1-1/2 inch from the ground.
4. Place concrete.
5. Level rack before concrete sets.
6. Support until dry.

### 3.4 CLEANING

A. Clean installed work to like-new condition. Do not use cleaning materials or methods that could damage finish.

### 3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

**END OF SECTION**

# SECTION 32 8423 - IRRIGATION SYSTEM

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Pipe and fittings, valves, sprinkler heads, emitters, and accessories.

B. Control system.

C. System design and construction.

### 1.2 RELATED REQUIREMENTS

A. Section 01 3000 - Administrative Requirements: Submittal Procedures.

B. Section 01 6000 - Product Requirements

C. Section 01 7800 - Closeout Submittals.

D. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.

E. Division 31 Section: Excavating for irrigation piping.

F. Division 31 Section: Excavating and backfilling for irrigation piping.

G. Division 31 Section: Backfilling for irrigation piping.

H. NMSU Engineering and Construction Design Guidelines, Volume 4, Rev. 6 May, 2020. Division 32 - Exterior Improvements.

### 1.3 REFERENCE STANDARDS

A. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

### 1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of the irrigation system with related work:

1. Verify, install, and test the irrigation point of connection before any irrigation system installation.
2. Installation sleeves coordination with hardscape construction.
3. Perform fine grading prior to staking.
4. Perform staking prior to trenching.

5. Generate As-built or "Record Drawing" documentation and perform testing prior to final grading.
6. Install, document, test, and verify irrigation system is fully functional prior to installation of landscape materials.

B. Pre-installation Meeting: Convene one week before commencing the work of this Section.

C. Instructional Training: Provide a four-hour (minimum) on-site irrigation system instructional training session to the Owner's representative prior to date of substantial completion. Include the following topics:

1. Winterization.
2. Spring startup procedures (Toro Tech Tip Bulletin #2009-01).
3. Controller operation, programming, and troubleshooting.
4. Grounding system maintenance.
5. Backflow preventer maintenance.
6. Any other topics that are pertinent to the system.

## 1.5 SUBMITTALS

A. Product Data: Provide data on system components, including the control system and wiring diagrams.

B. Qualification Data for Irrigation Installer:

1. Submit license, personnel, insurance, and equipment information to illustrate that the irrigation installer is capable of and legally qualified to perform the type and scale of work required.

C. Construction Schedule: Indicate when the pre-installation conference will occur and how irrigation design and construction activities, and testing, will fit into the overall project construction schedule and sequencing, including warranty periods.

D. Testing Data: Provide Irrigation point of connection test results.

E. Provide results of dynamic water pressure test.

F. Installation Progress Photos: Provide periodic photo documentation (minimum every two days) of the range of completed work for review.

G. Certificate: Certify that the products of this Section approved by the authority having jurisdiction.

## 1.6 AS-BUILT RECORDS

A. Submit an accurate plan of the installed irrigation system, including the actual locations of concealed and visible components, and submit before substantial completion.

B. Record Drawings and Documents:

1. Provide a clean, accurate, and professional as-built record drawing.
2. Be drafted onto a clean base of the original plan, drawn to scale.
3. Indicate components and locations of installed materials.
4. Have detailed legends and notes indicating special features and dimensions and essential component instructions.

C. Provide color hard copy and digital images of the document (PDF format) to the Architect.

D. Provide two 11" by 17" laminated waterproof controller sheets. Place one in the controller and submit one to the Owner.

E. Operation and Maintenance Data:

1. Provide instructions for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer's technical sheets, guides, and manuals.
2. Provide a schedule indicating the length of time each valve is required to be open to provide a determined amount of water.

F. Maintenance Materials: Provide the following for the Owner's use in the maintenance of the project.

1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Extra Drip Emitter: 25 of each type and size.
3. Extra Valve Keys for Manual Valves: Two.
4. Extra Valve Box Keys: Two.
5. Extra Valve Marker Keys: Two.
6. Wrenches: One for each type of head core and for removing and installing every head.

## 1.7 SUBSTITUTIONS

A. See Section 01 6300 - Product Substitution Procedures for submittal procedures.

## 1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section, with not less than [five] years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years of experience.

C. Irrigation System Documents:

1. Maintain and make available on-site, at every work time, the construction documents related to the installation of the irrigation system, including plan, detail drawings, specifications, addenda, and change orders.

## 1.9 TESTING

A. Coordinate testing and inspections with the Architect.

B. Give a minimum of 48 hours written notice to the Architect before inspection and testing.

C. Do not proceed with work following inspections or testing without written notice to proceed from the Architect.

## 1.10 HANDLING, STORAGE, AND PROTECTION

A. Ship, load, unload, and store materials following the manufacturer's recommendations.

B. Ship and deliver the pipes in unbroken bundles, packaged to provide adequate protection. Reject and remove from the site any pipe damaged or dropped in the delivery, unloading, or storage processes.

C. Protect and cover PVC pipe and fittings from direct sunlight to prevent discoloration or sun burning. Reject and remove any sunburned or discolored pipe.

D. Transport PVC pipe in a vehicle with a surface long enough to allow the pipe to lie flat without subjecting it to undue bending or concentrated external loads at any point. Replace dented, damaged, or defective pipe; before, during, or after the installation.

## 1.11 WARRANTY

A. See Section 01 7800 - Closeout Submittals.

B. Substantial or final completion inspection:

1. Coordinate a review of the completed or substantially completed irrigation system with the Architect. Substantially completed means that parts and components of the irrigation system are installed, functional and undamaged. Adjust sprinklers, test backflow devices until accepted, and the irrigation controller is installed and functioning. Provide complete "red-line" as-built record drawings of the installed irrigation system, noting any changes or deviations from that of the original design.

a. Demonstrate the operation of each zone valve and provide a walk-through to demonstrate the functionality of each irrigated area.

b. Demonstrate that the interiors of the valve boxes are dry and free from leaks or drips.

c. Provide a copy of the "red-line" irrigation as-built record drawings to the A/E for review and verification.

2. Generate a final observation report and make available to the Architect within a reasonable time. The inspection report may include "punch-list" items that need to be addressed to receive final acceptance. Provide a copy of the substantial or final completion observation record in the "Operations and Maintenance Manual".

C. Guarantee work for one year from the date of substantial completion, in addition to the manufacturer's guarantee and warranties, Repair or replace defective work, materials, leaks, trench settlement, and other work performed under this contract, at no additional expense to the Owner. The Contractor shall also keep drip emitters, valves, and valve boxes in adjustment and at the proper level and grade for the duration of the warranty period.

1. Correct operational difficulties in connection with the irrigation system that may occur within the specified guarantee period, with a reasonable length of time, depending upon the magnitude of the problem.

2. The Warranty shall cover the repair of damage to any part of the premises resulting from leaks or other defects in materials, equipment, or quality, to the satisfaction of and at no expense to the Owner.

3. The materials shall have a minimum guarantee against defects for one year from the date of acceptance. Some products may have extended manufacturer warranties, which shall apply to the end-user.

4. During the one year warranty period, if the amount of system leaks or breaks exceeds five occurrences, extend the warranty period to an additional one year. The Owner shall document leaks and breaks and provide them in writing to the Contractor.

D. Emergency Repairs: If the Contractor does not respond to the Owner's request for repair work within twenty-four hours, the Owner may proceed with the necessary repairs and charge the Contractor for expenses incurred in the repair work. These repairs will not relieve the Contractor of any part of his guarantee obligation.

E. System Adjustments: Upon completion of the installation, adjust system components, and controller to provide optimum system performance. The Owner will be responsible for minor adjustments to the system during the guarantee period.

F. Service Organizations: Provide the Owner with the names and addresses of permanent service organizations trained by the equipment manufacturers capable of providing satisfactory service within twenty-four hours.

G. If trench or valve box settlement of half-inch or more occurs within one year from the final acceptance, remove the finish grade treatment and refill and re-compact the soil structure. Reinstall the finish grade treatment material to the satisfaction of the Owner.

## PART 2 PRODUCTS

### 2.1 REGULATORY REQUIREMENTS

A. Comply with applicable code for piping and component requirements.

B. Provide a certificate of compliance from authority having jurisdiction indicating approval of products in the system.

### 2.2 IRRIGATION SYSTEM

A. Electric solenoid controlled underground irrigation system, with low point self-drain.

1. Source Power: 120 volts, 1.9 A., single phase.

B. Manufacturers:

1. Basis of design: As noted in the drawings.
2. Substitutions: See Section 01 6000 - Product Requirements.

### 2.3 PIPE MATERIALS

A. Schedule 40 Solvent Weld -Lateral / Mainline Piping - Sizes 3” and Smaller: Virgin polyvinyl chloride with integral solvent weld bells per ASTM D2241 and ASTM D1784, cell classification 12454-B type 1, grade.

B. Fittings: Type and style of connection to match the pipe.

C. Pipe Risers at Valves: 100 psi ABS pipe.

D. Drip Tubing: Three quarter inch polyethylene, commercial-grade, pressure rated to a minimum of forty-five psi. It may require stripes or markings for identification, per the drawings.

E. Solvent Cement: ASTM D2564 for PVC pipe and fittings.

F. Solder and Flux: ASTM B32 solder, with suitable flux.

G. Sleeve Material: PVC.

### 2.4 OUTLETS

A. Drip emitters shall be of the type, model, size, and manufacturer as specified on the drawings or approved equal.

## 2.5 VALVES

A. Valves, air release valves, pressure regulating valves, master valves, gate valves, drain valves, etc. shall be of the type, model, size, and manufacturer as specified on the drawings or approved equal.

B. Valve Boxes:

1. Large Valve Box: 1324-12 and 1324-15
    a. HDPE plastic body, 15 ¾" x 25 ¼" top access size, 24 ½" x 34" bottom size (two boxes for each component if required, refer to the drawings). The lid (for one box only) shall be HDPE plastic, T-style, bolt down cover.
        1) Carson, Applied Engineering or approved equal.
2. Medium Valve Box: 1419-18
    a. HDPE plastic body, 15 ¼" x 10 1/8" top access size, 19" x 13 7/8" bottom size. The lid shall be HDPE plastic, T-style, bolt down cover.
        1) Carson, Applied Engineering or approved equal.
3. Small Valve Box: 910
    a. HDPE plastic body, 10" round access with T-style, bolt down cover.
        1) Carson, Applied Engineering or approved equal.
4. The valve box lid or cover colors tan for use in rock mulch areas, or as noted on the drawings.

C. Backflow preventers shall be of the type, model, size, and manufacturer as specified on the drawings or approved equal.

## 2.6 CONTROLS

A. Controller: As noted on plans.

B. Valves: Hydraulic; normally open; hydraulic tubing, including required fittings and accessories.

C. Wire Conductors: Color coded.

# PART 3 EXECUTION

## 3.1 EXAMINATION

A. Verify location of existing utilities.

1. Irrigation point of connection for an existing water source:
    a. Locate existing piping.

b. identify the source, verify line size, and type.

c. Locate shut-off valves and confirm water shutdown before cutting into existing piping.

d. Proceed with the installation of the tap or connection, including the shut-off valve per the drawings.

e. Ensure no leakage from the new connection.

f. Proceed with testing.

2. Irrigation point of connection testing: Before any irrigation construction, verify and test the irrigation system point of connection.

a. Install a properly sized test assembly consisting of a connection fitting, water pressure gauge, flow meter, and shut-off valve to the downstream side of the point of connection. The test assembly should allow the Contractor to measure the dynamic water pressure at a particular gallon-per-minute flow and have the ability to shut-off water flow.

b. Provide or construct an appropriate drainage area sized to accommodate the volume of water necessary and required for proper testing without discharging into public right-of-way or onto adjacent private property.

c. Initiate a water flow equal to the highest gallon-per-minute flow demand of the irrigation system, as indicated in the drawings. Record the dynamic water pressure reading at the highest system flow demand. Shut off the test assembly valve. Record static water pressure at zero flow. Document recordings and test assembly make-up with digital photographs.

d. Report findings in writing to the Architect. The report should indicate the dynamic water pressure at the highest system flow and the static water pressure at zero discharge, and a photograph of the test assembly and a photograph for each gauge reading.

e. The Architect shall issue a written notice to proceed upon acceptable test results or give further instructions upon unexpected results. Do not install any part of the irrigation system without written notice to proceed.

3. Verify that required utilities are available, in proper location, and ready for use.

## 3.2 PREPARATION

A. Piping layout indicated is diagrammatic only. Route piping to avoid plants, ground cover, and structures.

B. Layout and stake locations of the system components:

Locate and mark underground utilities, public and private, recorded and unrecorded, before staking:

a. Perform the field staking and have the Architect approve the locations of the following components before installation:
1) Mainline piping

2) Lateral piping
3) Valves: shut-off, master, automatic, manual, air release, pressure regulating, drain, and others per the drawings
4) Controllers, accessories, and weather sensors

b. Perform the field staking using painted wooden stakes, flagging, and or ground paint, color-coordinated to the type of irrigation component.

C. Review layout requirements with other affected work. Coordinate sleeves under paving to accommodate the system.

## 3.3 TRENCHING

A. Trench and backfill per Section 31 2316.13 and Section 31 2323.

B. Trench to accommodate grade changes and slope to drains.

C. Maintain trenches free of debris, material, or obstructions that may damage the pipes.

## 3.4 INSTALLATION

A. Install pipe, valves, controls, and outlets following the manufacturer's instructions.

B. Connect to utilities.

C. Set outlets and box covers at finish grade elevations.

D. Provide thermal movement of components in the system.

E. Use threaded nipples for risers to each outlet.

F. Install control wiring per Section 26 0519. Provide 10 inch expansion coil at each valve to which controls are connected, and at 100 ft intervals. Bury wiring beside the pipe.

G. After the installation of the piping, and before outlets are installed and backfilling commences, open valves and flush system with a full head of water.

H. Point of connection installation:

1. Point of connection: Install the water source per the instructions on the construction documents, and the manufacturer's recommendations and instructions.

   a. Existing Water Source: Locate the piping stubbed out for irrigation use at the approximate location indicated on the drawing. Positively identify, install shut-off valve if none exists, connect to, and pipe to backflow prevention device as illustrated on the drawings.

2. Backflow Preventer:

   a. Install according to the Uniform Plumbing Code, the NEC, and the drawings. Protect backflow preventer from freezing with suitable heated enclosure and by draining and

blowing out with compressed air before freezing weather. Provide an appropriately sized and installed 120V power circuit with a plug-in electrical outlet for the backflow preventer heater. The 120-volt power circuit shall be sized and installed by a licensed electrician.

b. Provide Certified Backflow Test Certificate indicating a passing inspection by a certified backflow technician before placing in service or connecting to irrigation mainline. Present this certificate to the Owner and include a copy of it in the "Operations and Maintenance Manual."

3. Test port installation (for hydrostatic pressure test):

a. Provide and install a testing port accessible to the irrigation observer for hydrostatic pressure testing. The test port shall consist of a direct connection into the mainline piping structure and shall provide a shut-off valve and a ¼" FIPT connection point. Use an already installed service tee or termination point for the mainline connection. Remove the test port make-up components upon the successful completion of the hydrostatic testing.

I. PIPING SYSTEM INSTALLATION

1. General:

a. Adverse trenching conditions: No additional costs will be paid if the Contractor encounters any adverse trenching conditions.

b. Depth of Bury: Refer to the drawings.

2. Backfilling and Compaction:

a. Upon the completion of a particular section of the irrigation system, the Contractor may begin partial backfilling (center loading and thrust blocking of the piping structure). Leave joints, risers, and connections exposed for visual inspection during the hydrostatic testing. Only upon successful completion of the hydrostatic test can the backfill operation be completed for any particular section. Locate any leaks in the piping structure that cause unsuccessful hydrostatic test results, whether or not it is buried.

b. Backfill around pipe and 6" above pipe cannot contain rocks or stones larger than half-inch. Backfill from 6" above the pipe to finish grade cannot have any rocks or stones larger than 2" if the excavated trench material contains rocks exceeding half-inch, screen backfill to comply with criteria above. Remove unsuitable material from the site and dispose of properly.

c. In rocky areas, trench depth shall be six inches below the typical trench depth to allow for six inches of suitable backfill as padding for the pipe. Provide a minimum of six inches of padding on both sides of the pipe. The padding will serve as a buffer against the rock wall of the trench.

d. Place backfill in horizontal layers not exceeding six inches in depth; thoroughly tamp and compact with manual or mechanical compaction equipment to a minimum 95% standard proctor density. Place backfill to the exiting ground level or limits specified on the drawings. Refill trenches and sod repaired areas if settlement of trenches occurs within one year from date of completion.

3. PVC Pipe Installation:

a. Remove dirt and debris in the pipe before installation. Keep the pipe clean at any stage of the installation. Seal open ends of the pipe and fittings so that trench water, earth, or foreign substances will not enter the pipe or fittings. Where pipe ends are left for future expansion or connections, valve and cap as indicated on the drawings.

b. The full length of each length of the pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, joints, and couplings. Do not lay pipe in water or when trench or weather conditions are unsuitable for the work. Remove water to keep the bottom of the trench or excavation free and clear of water during the progress of the work. Pipe shall not lay if the temperature is 32F or below. Install the pipe to provide for expansion and contraction as recommended by the manufacturer.

c. The minimum horizontal clearance between lines in the same trench shall be four inches (4"). Install pipe shall in a straight line with changes in direction made with elbows and tees. Install piping to a positive slope to any manual drains so that water can drain from that part of the system.

d. Notify the Architecture and Engineering Services (A/E) and receive written authorization if pipe curving is necessary due to particular angles and site conditions, before installing. Retrench and reinstall the piping as directed for any section or length and at no additional cost to the Owner if any discovered unauthorized or unnecessary bending.

e. To accommodate repairs that may occur in the future, bending or curving of the pipe beyond the recommended limits of the manufacturer will not be permitted.

4. Sleeve Pipe - Hardscape Crossings:

a. New Construction:
   1) Unless otherwise noted, sleeve all hardscape crossings in the early stages of construction rather than installing the pipe after the hardscape is in place.
   2) Sleeve pipe shall be two sizes larger than the pipe to be sleeved. Sleeve pipe up to 4” shall be Schedule 40 PVC solvent weld. Sleeve pipe 6” and larger shall be Class 200 PVC gasket end.
   3) 24 volt wire shall be installed in a separate 2” Sch.40 PVC sleeve unless noted otherwise on the plan.
   4) Install the piping and wire in separate sleeves.

b. Existing Concrete or Asphalt with crossing greater than six feet (6’) in width:
   1) All sleeve crossings shall be made by means of mechanized directional boring. The Contractor may elect to bore each sleeve pipe separately or use one large bore with sleeve to install more than one sleeve pipe or conduit.
   2) The bore shall be done at the appropriate depth of bury for the particular utility (lateral, mainline or electrical) or at the deepest depth of bury if multiple utilities will be installed in the same bore sleeve.
   3) Locate and mark all existing utilities prior to boring.
   4) No type of water-jet bore methods may be used.

c. Existing Concrete or Asphalt with crossing less than six feet (6’) in width:
   1) Use a mechanical drill bore or impact bore only. Use any type of water-jet bore method is not permitted.

d. Alternative sleeve crossing method - by Architect approval only:
   1) With approval from the Architect only, the Contractor may saw cut the existing concrete or asphalt, excavate sleeve trench, install sleeve, backfill, compact and patch concrete or asphalt.
   2) The saw cut(s) shall be clean and straight. Properly dispose of the removed material.
   3) The patch shall be configured of the same material, and be of the same color, texture and finish as the existing material.
   4) Sleeve length past hardscape edges - The ends of each sleeve pipe shall extend or be trimmed to 6” past the edge of concrete of asphalt unless otherwise directed by the A/E.

5. Drip Tubing Installation - ¾” and ¼” Polyethylene:

   a. For ¾” polyethylene drip tubing, install the tubing in a meandering pattern, with long bends so as not to kink the tube. The ¾” tubing shall be installed within ten feet (10’) of each tree or shrub to be irrigated. The ¾” tubing shall be buried to a depth of 4”. The maximum length of tubing (from the source riser) is 75'. See also Drip Emitter Installation, in other parts of these specifications.

   b. For ¼” polyethylene or vinyl “spaghetti” tubing, install the tubing in a slightly meandering pattern from the ¾” tubing to the tree or shrub. The meandering shall allow for expansion and contraction, so that the tubing never becomes stretched tight. The maximum length of ¼” tubing is ten feet (10’). Only one drip emitter is allowed per run of ¼” tubing. The tubing shall be secured to the ground using landscape staples in two foot (2’) intervals. The tubing shall be installed prior to mulch material. Mulch material shall provide the cover for the tubing so that no tubing is exposed. If no mulch material is used, the tubing shall be buried at a depth of 4”. See also Drip Emitter Installation, in other parts of these specifications.

6. Flushing:

   a. Flush debris wholly and thoroughly from piping:
      1) Flush the piping system thoroughly at full water pressure-volume, after installing the piping and partially backfilling the trenches. Do not install automatic valves, air release valves, pressure regulation valves, quick coupler valves, or drip emitters before piping has been flushed and tested.
      2) If water pressure without the emission devices installed is not sufficient to provide adequate water flow from end risers, cap off enough risers closest to the water source to provide adequate flushing of the end riser assemblies.
      3) After the system is thoroughly flushed, risers shall be capped water-tight, and the system pressure tested following the testing section of these specifications.
      4) At the successful conclusion of the pressure test, install valves and emission devices and complete the backfill process.
      5) No flushing will be allowed through any emission device or valve other than isolation (gate or straight or ball). Any component other than isolation showing evidence of flushed debris shall be rejected and replaced at the Contractor's expense.

## 3.5 DRIP EMITTER INSTALLATION

A. General:

1. Drip emitters shall be of the manufacturer and model number specified on the drawings or approved equal, installed to grade, level, and plumb in every direction unless installed on sloping terrain.
2. Flush system piping thoroughly before the installation of the drip emitters.

## 3.6 FIELD QUALITY CONTROL

A. Before irrigation related construction, verify and test the irrigation system point of connection.

1. The test assembly should allow the Contractor to measure the dynamic water pressure at a particular gallon-per-minute flow and have the ability to shut off water flow.
2. Water from the test cannot discharge into a public right-of-way or adjacent property without written permission from the Owner.
3. Initiate dynamic water flow equal to the highest gallon-per-minute flow demand of the irrigation system. Record the dynamic water pressure reading at the highest system flow demand. Record static water pressure at zero flow. Document recordings and test assembly make-up with digital photographs.
4. Submit point of connection test results in a report to the Architect, and it shall include the date and time of testing, results, and photographs.

B. Staking: locate and mark (paint or flag) portions of the irrigation system for visual inspection by the Architect.

C. Hydrostatic Mainline Pressure Test:

1. Conduct a hydrostatic pressure test to be observed by the Architect.
2. Document the hydrostatic pressure test with digital photographs or video (with proof of date and time), at any stage of the testing. Provide the written testing to the Architect for review.
3. Pre-pressurize the mainline piping to approximately 90 PSI.
4. Record the digital pressure to the 1/4" FIPT connection (with isolation valve provided by the Contractor).
5. Document the pre-pressurized static water pressure.
6. Pressurize the mainline piping to a full 100 PSI test start pressure.
7. Document the 100 PSI pressure and then isolate the pressurizing device from the mainline piping structure.
8. Document the digital pressure gauge readings of the static pressure for one hour and provide them to the Architect for review.

9. A successful hydrostatic pressure test will have a recorded water pressure drop of less than or equal to 3.0 psi.
10. If the hydrostatic pressure test is not successful, make the necessary repairs and schedule a new water pressure test.

D. Before backfilling, test the system for leakage at the main piping to maintain 100 PSI pressure for one hour.

E. The system is acceptable if no leakage or loss of pressure occurs and system self drains during the test period.

## 3.7 BACKFILLING

A. Provide 3 inch sand cover over piping.

B. Backfill trench and compact to specified subgrade elevation. Protect piping from displacement.

## 3.8 SYSTEM STARTUP

A. Prepare and start the system following the manufacturer's instructions.

B. Adjust the control system to achieve the time cycles required.

C. Adjust head types for full water coverage as directed.

## 3.9 MAINTENANCE

A. Provide one complete spring startup and a fall shutdown by the installer, at no additional cost to the Owner.

**END OF SECTION**

# SECTION 32 9300 - PLANTS

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Preparation of subsoil.

B. Preparation of planting backfill mixture.

C. New trees, plants, and ground cover.

D. Mulch and Fertilizer.

E. Maintenance.

F. Tree Pruning.

### 1.2 RELATED REQUIREMENTS

A. Section 015639 - Temporary Tree and Plant Protection.

B. Division 31 Sections: for for grading and earthwork, including subsoil preparation for work of this section.

C. Section 32 8423 - Irrigation System.

### 1.3 DEFINITIONS

A. Weeds: Any plant life not specified or scheduled.

B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

### 1.4 REFERENCE STANDARDS

A. ANSI/ANLA Z60.1 - American National Standard for Nursery Stock.

B. ANSI A300 Part 1 - American National Standard for Tree Care Operations -- Tree, Shrub and Other Woody Plant Maintenance -- Standard Practices.

### 1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Certificate: Certify fertilizer and herbicide mixture approval by authority having jurisdiction.

C. Qualification Data for Landscape Installer:

1. Submit license, personnel, insurance and equipment information to illustrate that Landscape Installer is capable of and legally qualified to perform the type and scale of work required.

2. Submit a list of similar projects completed by Landscape Installer demonstrating capabilities and experience. Include project names, addresses and year completed and include names and addresses of project contacts.

D. Construction Schedule: indicating when the pre-installation conference will occur and how planting activities such as plant salvage, transplant and installation fit into the overall project construction schedule and sequencing, including maintenance and warranty periods.

E. Product Data:

1. Type and source of pesticides, herbicides, and fertilizers. Include project label and manufacturer's application instructions specific to this project.

2. Type, source and composition of soil and soil amendments.

3. Type, source and composition of weed barrier.

4. Type and source of staking materials.

5. List of plants including genus, species, variety, size, quantity and source.

F. Product Samples:

1. Mulch:

a. Submit in sealed plastic bags labeled with composition of materials by percentage weight and source of mulch. Each sample shall be typical of the lot of material to be furnished and provide an accurate representation of color, texture, and makeup.

b. Mineral Mulch: one quart volume sample of each mulch type.

2. Weed control barrier fabric.

3. Compost and soil amendments: one quart volume sample of each type.

4. Replacement soil mixture: one quart volume sample.

G. Soil Testing, Results and Recommendations:

1. Following award of the project, Contractor shall make recommendations for fertilizer and soil amendments for planting areas based on soil samples and testing by a regional laboratory during construction and prior to planting. Cost of testing is the responsibility of the Contractor.

2. Contractor shall submit results of soil tests for the landscaping indicated on the drawings to the Architect, and include the Contractor's recommendations for any changes to the specified fertilizer and soil amendment materials and ratios/rates.

H. Maintenance Data:

1. Two copies of recommended landscape operations and maintenance procedures to be followed by the Owner for one full year. Submit prior to expiration of required maintenance period.
2. Include maintenance instructions related to weed control, irrigation, fertilization, soil amendments, pest control and erosion control.

I. Record Drawings:

1. At final acceptance, Contractor shall furnish Record Drawings prepared by a qualified draftsperson showing the entire completed planting area. This is the responsibility of the Contractor and is not the responsibility of others.

J. Warranty: Sample of special warranty.

## 1.6 SUBSTITUTION

A. See Section 01 6000 - Product Requirements, for submittal procedures.

## 1.7 QUALITY ASSURANCE

A. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years documented experience.

B. Installer Qualifications: Company specializing in installing and planting the plants with five years experience.

C. Installer Field Supervision: Installer is required to maintain an experienced full-time supervisor on the project site when work is in session. Full-time supervisor must have a current copy of construction documents for the project on-site for reference at all times.

D. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.

E. Tree Pruning: Comply with ANSI A300 Part 1.

F. Maintenance Services: Performed by installer.

G. Plant Material Observation: Architect shall observe plant material at contractor yard or at site before installation for compliance with requirements for genus, species, variety, cultivar, size, condition of roots balls and root systems, pest, disease symptoms, and general quality. Architect retains the right to observe plant material at any time during progress of work and to reject unsatisfactory or defective material. Contractor will remove rejected plant material immediately from the project site. Contractor shall coordinate review of plant materials with project representative , landscpae architect and owner prior to plant installtion execution.

H. Pre-installation Conference: conduct pre-installation conference at project site prior to planting operations.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

B. Do not prune trees and shrubs before delivery.

C. Deliver plant life materials immediately prior to placement. Keep plants moist.

D. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

E. Provide erosion control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems or walkways.

## 1.9 FIELD CONDITIONS

A. Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of planting and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted to do so by the Owner and Architect. Do not proceed with interruption of services or utilities without Architect's written permission. Contractor shall notify the Architect no fewer that two days in advance of proposed interruption of each services or utility.

## 1.10 SCHEDULING AND SEQUENCING

A. Planting Restrictions:.

1. Do not install plants into saturated or frozen soils.
2. Do not install plants during inclement weather, such as rain or snow or during extremely hot, dry, or windy conditions.
3. Do not install plant life when wind velocity exceeds 30 mph.

B. Weather Limitations: Perform planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

C. Sequencing:

1. Schedule to plant after finish grades are established, after irrigation is installed and operational, and before seeding, sodding and mulching operations.

## 1.11 REVIEWS

A. Coordination between Contractor and Architect for reviews and observations shall be initiated by the Contractor 48 hours in advance.

B. Required reviews include:

1. Subgrade condition,
2. Amended and fine graded condition at finished grades,
3. Plant material review,
4. Condition during installation, and
5. Conditions following installation and mulch installation.

C. Rejected materials shall be removed immediately from the site. Expense for replacing substandard materials shall be borne by Contractor.

D. Contractor shall not proceed with work of the the next sequence without completing previous work.

## 1.12 PROJECT CLOSEOUT

A. Substantial completion shall be issued when the Contractor has completed all work in the contract, and the Architect is satisfied with the work.

B. Maintenance:

1. The Contractor shall maintain the planted areas regularly throughout the installation and maintenance period of 90 days following substantial completion.
2. Owner shall provide maintenance afterwards, per the recommendations outlined in the maintenance manual.
3. See Section 3.6 of this specification for description of potential maintenance activities.

C. Warranty:

1. Contractor shall warranty planting installation for a period of one full year after date of substantial completion against failures and defects including death and unsatisfactory growth as determined by the Architect, unless such failure is determined to be due to the Owner's negligence in following the Contractor's recommended maintenance procedure.
    a. Failures and defects may include, but are not limited to, death and unsatisfactory growth, including impacts from cold weather, structural failures including plants falling or blowing over, and deterioration of metals, metal finishes and other materials beyond normal weathering.
2. At a minimum, remedial warranty actions shall include:

a. Immediate removal and replacement of dead plant material unless required to plant in the next growing season

b. Plant replacement for plants that are 25% dead or in an unhealthy condition at the end of the warranty period

3. Contractor shall regularly inspect planted areas, and shall notify the Architect if they encounter site conditions unfavorable to the health of the plants.

4. Materials for replacement shall be of the same kind as used in the original installation unless directed otherwise by the Architect. It is the Contractor's responsibility to provide documentation of warranty treatment, repair or replacement. The Contractor shall coordinate documentation and any interim inspections with the Architect.

## 1.13 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide one year warranty. Replace dead or unhealthy plants

# PART 2 PRODUCTS

## 2.1 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of plants, fertilizer and herbicide mixture.

C. Plant Materials: Certified by federal department of agriculture; free of disease or hazardous insects.

## 2.2 PLANTS

A. Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

B. Complying with ANSI Z60.1.

C. Labeling: at least one plant of each variety, size, and caliper with a securely attached waterproof tag bearing legible designation of common name, full scientific name, including genus, species, hybrid, variety, and cultivar where applicable.

D. If formal arrangements or consecutive order of plants is shown on drawings, select stock for uniform habit, height and spread, and number the labels to assure symmetry in planting.

## 2.3 SOIL MATERIALS

A. Replacement Soil Mixture: soil will be required where grades are low, soil is missing, or soil has been contaminated and removed during construction.

1. Pre-approved Product Basis of Design: Soilutions Topsoil Blend (505-877-0220), www.soilutions.net .
2. Use of high quality local sources is preferred.

## 2.4 SOIL AMENDMENT MATERIALS

A. All amounts noted below are included for purposes of bidding. Following award of the project, Contractor shall make recommendations for soil amendment materials based on results of soil samples taken from the site, and tested by a regional laboratory. Cost of testing is the responsibility of the Contractor.

B. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis..

1. Nitrogen: 7 percent.
2. Phosphoric Acid: 2 percent.
3. Soluble Potash: 1 percent.

C. Compost:

1. Pre-approved Product Basis of Design: where compost is called for on the drawings or in the specifications, assume use of Soilutions Premium Compost (505-877-0220), www.soilutions.net.
2. Use of high quality local sources is preferred.
3. For purposes of bidding, plant pits are to be filled with a blend of native soil removed from the pit and premium compost. The ratio shall be 3/4 native soil blended with 1/4 premium compost.

## 2.5 MULCH MATERIALS

A. As indicated on the drawings.

## 2.6 ACCESSORIES

A. Fertilizer

1. Pre-approved Product Basis of Design: For bidding purposes assume uniform application of Biosol Forte 7-2-1 over all planting pits and beds. This is a slow release organic fertilizer that shall be blended into planting backfill.

2. Rates: per manufacturer's recommendations for type of plant material.

B. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

C. Herbicides and Pesticides: Herbicides and pesticides are not required, but may be used.

1. Contractor shall submit request for use and approval to the Architect.

2. Submittal shall include name of product(s) and description of use. If approved, application shall be per manufacturer's recommendations.

3. Proposed herbicides and pesticides shall have a least hazardous (Tier III) ranking.

D. Wrapping Materials: Burlap.

E. Stakes and Guys:

1. Upright Stakes: rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain and other defects, 2" x 2" nominal by length indicated. Pointed at one end.

2. Flexible Ties: wide rubber or elastic band or straps of length required to reach stakes.

F. Weed Control Barrier: non-woven geotextile filter fabric. Polypropylene or polyester fabric, 3.5 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

## PART 3 EXECUTION

### 3.1 EXAMINATION

A. Verify that finish grades are properly set to accommodate plant material and mulch.

### 3.2 PREPARATION

A. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

B. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

C. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.

D. Scarify subsoil to a depth of 6 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

E. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

## 3.3 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after initial raking of topsoil.

C. Mix thoroughly into upper 2 inches of topsoil.

D. Lightly water to aid the dissipation of fertilizer.

## 3.4 PLANTING

A. Excavation:

1. Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center of bottom area slightly raised to support root ball and assist in drainage away from center. Do not further disturb the base. Scarify sides of planting pit.
2. Excavate planting pits to the size noted on the drawings.
3. Keep excavations covered or otherwise protected when unattended by Contractor's personnel.
4. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

B. Planting Backfill Mixture:

1. Screen excavated soil to remove debris 1" or larger.
2. Create planting backfill mixture by blending screened native soil with compost at a rate of 3/4 native soil and 1/4 compost for use as backfill around plants.
3. Apply soil conditioner at rates per manufacturer.

C. Setting Plants

1. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If not visible, remove soil from the root ball in a level manner from the rootball to where the top-most root emerges from the trunk.
2. Before planting, remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly, do not break.
3. Set stock plumb in center of planting pit with root flare 1 inch above adjacent finish grade.
4. Backfill with planting mixture around rootball in 4" maximum layers - tamping to settle soil and eliminate voids and air pockets.

5. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. repeat watering until no more water is absorbed.
6. Apply fertilizer per manufacturer's recommendations
7. Continue watering until no more water is absorbed.

D. Planting on Slopes: when planting on slopes, set the plant so the root flare is on the uphill side and is flush with surrounding soil on the slope. The edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

## 3.5 PLANT SUPPORT

A. Tree staking is not required, but may be provided per plans and specifications to protect trees during the warranty period.

B. Brace plants vertically as indicated on drawings

## 3.6 TREE PRUNING

A. Perform pruning of trees as recommended in ANSI A300, but only at the direction of the Architect. Do not prune trees prior to delivery to the site, or without approval of the Architect.

## 3.7 MAINTENANCE

A. Provide maintenance at no extra cost to Owner; Owner will pay for water.

B. Maintain plant life for three months after Date of Substantial Completion.

C. Irrigate sufficiently to saturate root system and prevent soil from drying out.

D. Cultivate and weed plant beds and tree pits.

E. Remove dead or broken branches and treat pruned areas or other wounds.

F. Control growth of weeds. Primary control shall be by hand removal, cultivation, and mowing. Apply herbicides as a last resort and in accordance with manufacturer's instructions.

G. Control insect damage and disease. Apply pesticides in accordance with manufacturers instructions.

H. Remedy damage from use of herbicides and pesticides.

I. Replace mulch when deteriorated.

J. Maintain staking. Repair or replace accessories when required.

**END OF SECTION**