



**CHAMPAIGN COUNTY BOARD
FACILITIES COMMITTEE AGENDA
County of Champaign, Urbana, Illinois**

Tuesday, October 4, 2022, at 6:30p.m.
Shields-Carter Meeting Room
Brookens Administrative Center
1776 E. Washington St., Urbana, IL 61802

Committee Members:

Steve Summers – Chair Emily Rodriguez
Stan Harper – Vice Chair Leah Taylor
Jim Goss
Jenny Lokshin Jodi Wolken
Bethany Vanichtheeranont

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Agenda

- I. Call to Order and Roll Call
- II. Approval of Agenda/Addenda
- III. Approval of Minutes – September 6, 2022 1-3
- IV. Public Participation
- V. Communications
- VI. New Business
 - A. Update on ITB#2021-003 Satellite Jail HVAC Replacement
 - B. Update on emergency purchase and installation of new chiller at ILEAS
 - C. Discussion and Approval of Award of Contract ITB #2022-007 County Plaza Park Deck Renovation (Bid Summary and Letter from Bailey Edward Design Handout)
 - D. Update on ITB #2022-009 Satellite Jail Consolidation Bid
 - E. Update and Approval of ITB #2022-008 County Plaza Renovation Bid Specifications and Drawings 95% Complete – Bailey Edward Design – Karla Smalley – (Bid Document Attached) 4-998

VII. Other Business

- A. Closed session pursuant to 5 ILCS 120/2(c)5 to discuss the purchase or lease of real estate property for the use of the public body.

VIII. Presiding Officer's Report

- A. Future Meeting – **Tuesday, November 1, 2022 @ 6:30pm**

IX. Designation of Items to be Placed on the Consent Agenda

X. Adjournment

All meetings are at Brookens Administrative Center – 1776 E Washington Street in Urbana – unless otherwise noted. To enter Brookens after 4:30 p.m., enter at the north (rear) entrance located off Lierman Avenue. Champaign County will generally, upon request, provide appropriate aids and services leading to effective communication for qualified persons with disabilities. Please contact Administrative Services, 217-384-3776, as soon as possible but no later than 48 hours before the scheduled meeting.

**CHAMPAIGN COUNTY BOARD
FACILITIES COMMITTEE
County of Champaign, Urbana, Illinois**

MINUTES – Pending Approval

DATE: Tuesday September 6, 2022
TIME: 6:30 p.m.
PLACE: Lyle Shields Meeting Room
Brookens Administrative Center, 1776 E. Washington St., Urbana IL 61802

Committee Members

Present: Steve Summers, Jodi Wolken, Jenny Lokshin, Emily Rodriguez, Leah Taylor, Bethany Vanichtheeranont, Jim Goss

Absent: Stan Harper

County Staff: Dana Brenner (Facilities Director), Kyle Patterson (County Board Chair), Dan Busey (Recording Clerk)

Others Present: Chuck Reifsteck, (Reifsteck Reid Architecture),
Karla Smalley (Bailey Edward Architecture), Matthew Banach (States Attorney)

Agenda

I. Call to Order and Roll Call

Committee Chair Summers called the meeting to order at 6:33 P.M.

II. Approval of Agenda/Addenda

Moved by Ms. Lokshin to approve the agenda; seconded by Mr. Goss. Upon Voice Vote, the **Motion Carried Unanimously.**

III. Approval of Minutes – August 2, 2022

Moved by Mr. Goss to approve the minutes from August 2, 2022; seconded by Ms. Taylor. Upon Voice Vote, the **Motion Carried Unanimously.**

IV. Public Participation

None.

V. Communications

None.

VI. New Business

A. Update on ITB#2021-003 Satellite Jail HVAC Replacement. Mr. Brenner, Facilities Director, informed the committee that the air handlers have arrived on site. A tentative schedule has been sent to all parties involved. Mr. Brenner went over the schedule of replacement of each air handler that would make the most sense for the

comfort of the occupants. Mr. Brenner cautioned that there may be pause do to cool or heat to minimize the disruption of the inhabitants of the facility. Davis-Houk has inspected the equipment, and everything appears to be in working order. Ms. Lokshin and Mr. Brenner had a brief discussion about what necessitates acceptable weather conditions. Mr. Brenner stressed that the replacement would caution on the side of safety and comfort.

- B. Update on emergency purchase and installation of new a chiller at ILEAS. The chiller arrived on the 26th of August and all the components have been checked. Instillation will begin September 7th. The replacement in full will take about two weeks from start to finish. Mr. Summers expressed his optimism of the outlook of the project compared to prior updates.
- C. Discussion and Approval of ITB #2022-007 County Plaza Park Deck Renovation. Mr. Brenner explained that this portion of the project is being broken out separately and earlier than the County Plaza renovation because it will need to be safe to begin construction on the actual building itself. Karla Smalley, Bailey Edward Architecture, broke down how and what will be replaced on the parking deck. Ms. Smalley mentioned that getting this work out of the way early would help to not impede any of the restoration to the building. Mr. Goss and Ms. Smalley discussed the timeline of completing the renovation to the parking deck. The project should be done mid to late summer of 2023 possibly earlier. Mr. Goss **Moved** to approve the County Plaza Parking Deck Renovation; seconded by Ms. Lokshin. **The Motion Carried Unanimously.**
- D. Update on ITB #2022-009 Satellite Jail Consolidation Design Development and Budget and Schedule Discussion - Chuck Reifsteck, Reifsteck Reid Architecture, informed the committee that his firm is nearing the completion of the construction documents phase. The project should go to bid on September 27th, a pre bid conference will take place October 13th, bids will be due on November 2nd. Approval of the contract will then take place on the 17th of November full County Board Meeting, if approved, notice to proceed would be sent in early December. Mr. Summers and Mr. Reifsteck had a conversation about considering the possibility of unworkable weather. Ms. Rodriguez and Mr. Reifsteck had a conversation about the 100% completion timeline of the construction documents.
- E. Update on ITB #2022-008 County Plaza Renovation Project, Budget, and Schedule Discussion. Karla Smalley gave an update on way finding signage, stakeholder involvement, and floor plans. Ms. Lokshin asked if anyone on the design committee, that has no background in county business, is involved. Ms. Lokshin stated she would like someone who is not an expert to be involved. Ms. Rodriguez said that the input of the community should be sought out and that it would make more sense if this person were a woman. Reason being that 51% of the community are women.
- F. Discussion and Approval of PLA Agreement. Mr. Banach went over the specifics of the PLA agreement, where much of the parameters included came from, and updates to the document. Mr. Goss inquired about where the substantive changes of the document derived from. Mr. Banach responded that the equal opportunity piece was an important addition as well as added monitoring mechanisms. Mr. Banach then sited specific clarifications that had been made to different sections of the document. Ms. Rodriguez asked about the possibility of adding veterans as an equal opportunity

minority. She went on to ask the differences between the authority of the school districts and the county. Mr. Banach said that the University of Illinois PLA seemed to be a more complete document as opposed to Unit 4, which is why it was used. Mr. Banach and Ms. Rodriguez discussed home rule status and why this PLA is not being adopted as a blanket PLA for all projects. Mr. Summers stated that he believes that as this is the first PLA that it is a good idea to move forward expeditiously. Mr. Summers also pointed out the ability to track the different groups who apply through the implementation of this PLA. Mr. Banach went over the reporting requirement and goals of the PLA that will be able to be tracked as they are met. Ms. Lokshin **Moved** to approve the PLA Agreement; seconded by Ms. Taylor. **The Motion Carried by voice vote.**

- G. Update and Discussion of Courthouse Parking Lot. Mr. Brenner gave a history of changing the parking at the courthouse to primarily staff, other than ADA spots. The public is still parking in the employee spots on a daily occurrence, however. Mr. Brenner is looking into gated entry for courthouse employees and separation of the ADA spaces from the employee parking. Mr. Brenner proposed hiring a Civil Engineer to investigate restructuring the lot.

VII. Other Business

- A. Semi-annual Review of CLOSED Session Minutes. **Moved** by Ms. Vanichtheeranont to keep the minutes closed; seconded by Ms. Lokshin, the **Motion Carried Unanimously.**

VIII. Presiding Officer's Report

- A. Future Meeting – **Tuesday, October 4, 2022 @ 6:30pm**

IX. Designation of Items to be Placed on the Consent Agenda

VI. C

X. Adjournment

The meeting adjourned at 7:08 P.M.

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PROJECT MANUAL

CHAMPAIGN COUNTY PLAZA RENOVATION

FOR

CHAMPAIGN COUNTY, ILLINOIS
102 E. Main Street
URBANA, ILLINOIS 61801

95% CONSTRUCTION DOCUMENTS

Architect's Project # 21212

ITB # 2022-008

October 4, 2022

Bailey Edward Design, Inc.
1103 S. Mattis Avenue
Champaign, Illinois 61821
217.363.3375

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SECTION 02 41 00 - DEMOLITION

PART 1 GENERAL

2.01 SECTION INCLUDES

- A Selective demolition of built site elements.
- B Selective demolition of building elements for alteration purposes.
- C Abandonment and removal of existing utilities and utility structures.

2.02 RELATED REQUIREMENTS

- A Section 01 10 00 - Summary: Limitations on Contractor's use of site and premises.
- B Section 01 10 00 - Summary: Description of items to be removed by Owner.
- C Section 01 10 00 - Summary: Description of items to be salvaged or removed for re-use by Contractor.
- D Section 01 56 00 Temporary Barriers and Enclosures: Site fences, security, protective barriers, and waste removal.
- E Section 01 73 29- Cutting and Patching.
- F Section 07 01 50.19 - Preparation for Re-Roofing: Removal of existing roofing, roof insulation, flashing, trim, and accessories.

2.03 REFERENCE STANDARDS

- A NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations 2022.

2.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B See Section 01 33 23 Shop Drawings, Product Data and Samples for submittal procedures.
- C Site Plan: Indicate:
 - 1. Areas for temporary construction and field offices.
- D Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

2.05 QUALITY ASSURANCE

- A Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of five years of documented experience.

PART 3 EXECUTION

4.01 DEMOLITION

- A Remove paving and curbs required to accomplish new work.
- B Remove concrete slabs on grade as indicated on drawings.
- C Remove other items indicated, for salvage, relocation, recycling, and [_____].

4.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.

2. Comply with applicable requirements of NFPA 241.
 3. Provide, erect, and maintain temporary barriers and security devices.
 4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 5. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
 6. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
 7. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
- B Do not begin removal until receipt of notification to proceed from Owner.
- C Protect existing structures and other elements to remain in place and not removed.
1. Provide bracing and shoring.
 2. Prevent movement or settlement of adjacent structures.
 3. Stop work immediately if adjacent structures appear to be in danger.
- D Minimize production of dust due to demolition operations. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- E Perform demolition in a manner that maximizes salvage and recycling of materials.
1. Dismantle existing construction and separate materials.
 2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.
- F Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

4.03 EXISTING UTILITIES

- A Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.
- B Protect existing utilities to remain from damage.
- C Do not disrupt public utilities without permit from authority having jurisdiction.
- D Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

4.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
1. Verify construction and utility arrangements are as indicated.
 2. Report discrepancies to Architect before disturbing existing installation.
 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

- B Maintain weatherproof exterior building enclosure, except for interruptions required for replacement or modifications; prevent water and humidity damage.
- C Remove existing work as indicated and required to accomplish new work.
 - 1. Remove items indicated on drawings.
- D Services including, but not limited to, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications: Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems to remain in operation, and maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Verify that abandoned services serve only abandoned facilities before removal.
 - 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings. Remove back to source of supply where possible, otherwise cap stub and tag with identification.
- E Protect existing work to remain.
 - 1. Prevent movement of structure. Provide shoring and bracing as required.
 - 2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
 - 3. Repair adjacent construction and finishes damaged during removal work.
 - 4. Patch to match new work.

4.05 DEBRIS AND WASTE REMOVAL

- A Remove debris, junk, and trash from site.
- B Leave site in clean condition, ready for subsequent work.
- C Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 02 41 00

SECTION 03 35 11 - CONCRETE FLOOR FINISHES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Surface treatments for concrete floors and slabs.
- B Clear coatings.
- C Clear penetrating sealers.
- D Polished concrete.

1.02 RELATED REQUIREMENTS

- A Section 03 30 00 - Cast-in-Place Concrete: Finishing of concrete surface to tolerance; floating, troweling, and similar operations; curing.

1.03 SUBMITTALS

- A Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.
- B Product Data: Manufacturer's published data and installation instructions for concrete polishing system and finishing products, including manufacturer's installation instructions, information on compatibility of different products, and limitations.
- C Warranty Documentation: Manufacturer warranty; ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

- A Deliver materials in manufacturer's sealed packaging, including application instructions.

1.05 WARRANTY

- A Correct defective work within a two-year period commencing on the Date of Substantial Completion.

PART 2 PRODUCTS

2.01 CONCRETE FLOOR FINISH APPLICATIONS

- A Penetrating Clear Sealer:
 - 1. Use at following locations: carpet and resilient tile.
- B Clear Coating:
 - 1. Use at following locations: Janitor Closets.
- C Polished Finish:

2.02 COATINGS

- A High Gloss Clear Coating: Transparent, nonyellowing, acrylic polymer-based coating.
 - 1. Composition: Solvent-based.
 - 2. Nonvolatile Content: 15 percent, minimum, when measured by volume.
 - 3. Products:
 - a. Concrete Sealers USA; [____]: www.concretesealersusa.com/#sle.
 - b. PROSOCO, Inc; LSGuard: www.prosoco.com/consolideck/#sle.
 - c. W. R. Meadows, Inc; Decra-Seal W/B: www.wrmeadows.com/#sle.
 - 4. Composition: Water-based.
 - a. Nonvolatile Content: 15 percent, minimum, when measured by volume.
 - b. Products:
 - 1) Concrete Sealers USA; [____]: www.concretesealersusa.com/#sle.
 - 2) Dayton Superior Corporation; [____]: www.daytonsuperior.com/#sle.
 - 3) PROSOCO, Inc; LSGuard: www.prosoco.com/consolideck/#sle.
- B Low Gloss Clear Coating: Transparent, nonyellowing, acrylic polymer-based coating.

1. Composition: Solvent-based.
 2. Nonvolatile Content: 20 percent, minimum, when measured by volume.
 3. Products:
 - a. Clemons Concrete Coatings; [____]: www.clemonsconcretecoatings.com/#sle.
 4. Composition: Water-based.
 - a. Nonvolatile Content: 20 percent, minimum, when measured by volume.
 - b. Products:
 - 1) Concrete Sealers USA; TS202: www.concretesealersusa.com/#sle.
- C Clear, Penetrating, Moisture Vapor-Resistant Coating: Vapor-resistant and pH-reducing coating recommended by manufacturer for new and existing concrete floors and slabs.
1. Products:
 - a. LATICRETE International, Inc; Vapor Ban Primer ER: www.laticrete.com/#sle.
 - b. Rust-Oleum Corporation; TVB Water-Based Topside Vapor Barrier: www.rustoleum.com/#sle.
- D Penetrating Sealer: Transparent, nonyellowing, water- or solvent-based coating.
1. Composition: Siloxane.
 - a. Products:
 - 1) Concrete Sealers USA; [____]: www.concretesealersusa.com/#sle.
 - 2) SureCrete Design Products; [____]: www.surecretedesign.com/#sle.
 - 3) Substitutions: See Section 01 62 04 Substitution Procedures.

2.03 POLISHED CONCRETE SYSTEM

- A Polished Concrete System: Materials, equipment, and procedures designed and furnished by a single manufacturer to produce dense polished concrete of the specified sheen.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that floor surfaces are acceptable to receive the work of this section.
- B Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.02 GENERAL

- A Apply materials in accordance with manufacturer's instructions.

3.03 COATING APPLICATION

- A Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
- B Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.
- C Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

3.04 CONCRETE POLISHING

- A Execute using materials, equipment, and procedures specified by manufacturer, using manufacturer approved installer.
1. Satin Finish: Reflecting images from side lighting.
- B Protect finished surface as required and as recommended by manufacturer of polishing system.

END OF SECTION 03 35 11

SECTION 04 22 00 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.

1.2 DEFINITIONS

- ##### A. CMU(s): Concrete masonry unit(s).

1.3 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- ##### A. Material Certificates: For each type and size of product. For masonry units, include data on material properties.
- ##### B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

- ##### A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work. See BIA Technical Notes 16B and NCMA TEK 7-3 for information on determining fire-resistance ratings of masonry walls.
- C. Provide the concrete masonry units as indicated on the Drawings.

2.2 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C91/C91M.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cemex S.A.B. de C.V.
 - b. Holcim (US) Inc; LafargeHolcim.
 - c. Lafarge North America Inc.
 - d. Lehigh Hanson; HeidelbergCement Group.
- E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Davis Colors.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. Lanxess Corporation.
 - d. Solomon Colors Inc.
- F. Aggregate for Mortar: ASTM C144.
 - 1. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Water: Potable.

2.3 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
 - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
 - 2. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
 - 3. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 - 1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized-steel wire.
 - 2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-0.25-inch-diameter, hot-dip galvanized-steel wire.
- C. Partition Top Anchors: 0.105-inch-thick metal plate with a 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- D. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

2.4 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

2.5 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

- C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Property Specification. Provide the following types of mortar for applications stated unless another type is indicated.
 - 1. Use Type N Type S.
- D. Grout for Unit Masonry: Comply with ASTM C476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C476, paragraph 4.2.2 for 28-day compressive strength, but not less than 2000 psi.
 - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143/C143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.2 TOLERANCES

- A. Dimensions and Locations of Elements:

- 1. For dimensions in cross section or elevation, do not vary by more than plus minus 1/4 inch.
- 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
- 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch.

- B. Lines and Levels:

- 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
- 2. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet.

- C. Joints:

- 1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.

2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

3.4 MORTAR BEDDING AND JOINTING

- A. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- B. Tool exposed joints flush when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch. Lap reinforcement a minimum of 6 inches.
 1. Space reinforcement not more than 16 inches o.c..
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

3.6 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
 1. Provide an open space not less than 1/2 inchwide between masonry or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.

2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.
4. Drill and epoxy anchors as required for solid units.

3.7 REPAIRING, POINTING, AND CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
 2. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.8 MASONRY WASTE DISPOSAL

- A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 1. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 22 00

SECTION 05 31 00 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.
2. Noncomposite form deck.
3. Supplementary framing for openings as shown on Drawings.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 05 12 00 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 05 50 00 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.
2. Noncomposite form deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.

B. Installer Qualifications: Company specializing in performing the work of this Section with minimum 5 years experience, continuous.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

- B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

2.2 ROOF DECK

- A. Manufacturers:
 - 1. Canam Steel Corporation: www.cscsteelusa.com
 - 2. Nucor-Vulcraft Group: www.vulcraft.com
 - 3. Epic Metals Corporation: www.epicmetals.com
- B. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
 - 1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), **Grade 33** minimum, Type 1, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - 2. Profile Depth: **1-1/2 inches, Fluted**
 - 3. Design Uncoated-Steel Thickness: 21 gage
 - 4. Span Condition: **Three Span**
 - 5. Side Laps: Lapped, connected
 - 6. End Joints: Lapped, connected
 - 7. Factory punch holes, of size and arrangement indicated, into each deck cell at preset inserts and header duct locations.

2.3 NON-COMPOSITE FLOOR DECK

- A. Manufacturers:
 - 1. Canam Steel Corporation: www.cscsteelusa.com
 - 2. Nucor-Vulcraft Group: www.vulcraft.com
 - 3. Epic Metals Corporation: www.epicmetals.com
- B. Fabrication of Non-Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with SDI C, with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), **Grade 33** minimum, Type 1, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
2. Profile Depth: **1-1/2 inches, Fluted**
3. Design Uncoated-Steel Thickness: 20 gage
4. Span Condition: **Three Span**
5. Side Laps: Lapped, connected
6. End Joints: Lapped, connected
7. Factory punch holes, of size and arrangement indicated, into each deck cell at preset inserts and header duct locations.

2.4 ACCESSORIES

- A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, **No. 10** minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of **33,000 psi** not less than **20 gage** design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of **33,000 psi** of same material and finish as deck, and of thickness and profile **recommended by SDI standards for overhang and slab depth**.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, **0.0598 inch (16 gage)** thick, with factory-punched hole of **3/8-inch** minimum diameter.
- J. Flat Sump Plates: Single-piece steel sheet, **0.0747 inch (14 gage)** thick, of same material and finish as deck. For drains, cut holes in the field.
- K. Recessed Sump Pans: Single-piece steel sheet, **0.0747 inch (14 gage)** thick, of same material and finish as deck, with **3-inch** wide flanges and **level** recessed pans of **1-1/2-inch** minimum depth. For drains, cut holes in the field.
- L. Galvanizing Repair Paint: **SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight**.
- M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
 - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than **1-1/2 inches** long, and as follows:
 - 1. Weld Diameter: **5/8 inch**, nominal.
 - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds **12 inches apart, maximum**.
 - 3. Weld Washers: Install weld washers at each weld location.

- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or **18 inches**, and as follows:
 - 1. Mechanically fasten with self-drilling, **No. 10** diameter or larger, carbon-steel screws.
 - 2. Mechanically clinch or button punch.
 - 3. Fasten with a minimum of **1-1/2-inch** long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches**, with end joints as follows:
 - 1. End Joints: **Lapped 2 inches, minimum**
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and **mechanically fasten** flanges to top of deck. Space **mechanical fasteners** not more than **12 inches** apart with at least one **fastener** at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and **mechanically fasten**.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. **Mechanically fasten** to substrate to provide a complete deck installation.
 - 1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.4 INSTALLATION OF FLOOR DECK

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - 1. Weld Diameter: **5/8 inch**, nominal.
 - 2. Weld Spacing:
 - a. Weld edge ribs of panels at each support. Space additional welds an average of **12 inches** apart, but not more than **18 inches** apart.
 - b. Space and locate welds as indicated.
 - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or **36 inches**, and as follows:
 - 1. Mechanically fasten with self-drilling, **No. 10** diameter or larger, carbon-steel screws.
 - 2. Mechanically clinch or button punch.
 - 3. Fasten with a minimum of **1-1/2-inch** long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches** with end joints as follows:

1. End Joints: **Lapped**

- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure in accordance with SDI recommendations unless otherwise indicated.
- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, in accordance with SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.
- F. Install piercing hanger tabs at **14 inches** apart in both directions, within **9 inches** of walls at ends, and not more than **12 inches** from walls at sides unless otherwise indicated.

3.5 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.
- B. Repair Painting:
 - 1. Wire brush and clean rust spots, welds, and abraded areas on **both surfaces** of prime-painted deck immediately after installation, and apply repair paint.
 - 2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

END OF SECTION 05 31 00

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Formed steel stud interior wall framing.
- B Exterior wall sheathing.

1.02 RELATED REQUIREMENTS

- A Section 05 31 00 - Steel Decking.
- B Section 06 10 00 - Rough Carpentry: Wood blocking and miscellaneous framing.
- C Section 06 10 00 - Rough Carpentry: Roof and wall sheathing.
- D Section 09 21 16 - Gypsum Board Assemblies: Lightweight, non-load bearing metal stud framing.
- E Section 09 21 16 - Gypsum Board Assemblies: Gypsum-based sheathing.
- F Section 09 22 16 - Non-Structural Metal Framing.
- G Section 09 51 00 - Acoustical Ceilings: Ceiling suspension system.

1.03 REFERENCE STANDARDS

- A AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members 2016, with Supplement (2020).
- B ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- C ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- D ASTM C955 - Standard Specification for Cold-Formed Steel Structural Framing Members 2018, with Editorial Revision.
- E ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories 2020.
- F ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing 2017.
- G ASTM C1396/C1396M - Standard Specification for Gypsum Board 2017.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordinate with work of other sections that is to be installed in or adjacent to the metal framing system, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data on standard framing members; describe materials and finish, product criteria, limitations.
- C Manufacturer's Installation Instructions: Indicate special procedures, conditions requiring special attention

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Metal Framing:
 - 1. CEMCO: www.cemcosteel.com/#sle.
 - 2. ClarkDietrich: www.clarkdietrich.com/#sle.
 - 3. Jaimes Industries: www.jaimesind.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B Framing Connectors and Accessories:

1. Same manufacturer as metal framing.

2.02 FRAMING SYSTEM

- A Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.

2.03 FRAMING MATERIALS

- A Studs and Track: ASTM C955; studs formed to channel, C- or Sigma-shaped with punched web; U-shaped track in matching nominal width and compatible height.

1. Gauge and Depth: As indicated on drawings.

- B Framing Connectors: Factory-made, formed steel sheet.

1. Material: ASTM A653/A653M SS Grade 33 and 40 (minimum), with G90/Z275 hot dipped galvanized coating for base metal thickness less than 10 gauge, 0.1345 inch, and factory punched holes and slots.
2. Structural Performance: Maintain load and movement capacity required by applicable code.
3. Movement Connections: Provide mechanical anchorage devices that accommodate movement using slotted holes, shouldered screws or screws and anti-friction or stepped bushings, while maintaining structural performance of framing. Provide movement connections where indicated on drawings.
 - a. Where continuous studs bypass elevated floor slab, connect stud to slab in manner allowing vertical and horizontal movement of slab without affecting studs; allow for minimum movement of 1/2 inch.
 - b. Where top of stud wall terminates below structural floor or roof, connect studs to structure in manner allowing vertical and horizontal movement of slab without affecting studs; allow for minimum movement of 1/2 inch.
 - c. Provide top track with long leg track and head of wall movement connectors; minimum track length of 10 feet.
4. Fixed Connections: Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.

2.04 FASTENERS

- A Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.

- B Anchorage Devices: Powder actuated.

2.05 WALL SHEATHING

- A Gypsum Board Wall Sheathing: See Section 09 21 16.

2.06 ACCESSORIES

- A Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that substrate surfaces are ready to receive work.
- B Verify field measurements prior to commencing with work. If any discrepancies exist, alert architect immediately.

3.02 INSTALLATION OF STUDS

- A Install components in accordance with manufacturers' instructions and ASTM C1007 requirements.
- B Provide deflection allowance in stud track, directly below horizontal building framing at non-load bearing framing.

- C Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.

3.03 INSTALLATION OF WALL SHEATHING

- A Install wall sheathing with long dimension parallel to wall studs, with ends over firm bearing and staggered , using self-tapping screws.
 - 1. Provide steel diagonal bracing at corners with foam insulation or gypsum board wall sheathing.

END OF SECTION 05 40 00

SECTION 05 52 13 - PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A Stair railings and guardrails.

1.02 RELATED REQUIREMENTS

A Section 03 30 00 - Cast-in-Place Concrete: Placement of anchors in concrete.

B Section 05 51 00 - Metal Stairs: Handrails other than those specified in this section.

C Section 05 51 00 - Metal Stairs: Attachment plates for handrails specified in this section.

D Section 09 21 16 - Gypsum Board Assemblies: Placement of backing plates in stud wall construction.

E Section 09 91 23 - Interior Painting: Paint finish.

1.03 REFERENCE STANDARDS

A ADA Standards - 2010 ADA Standards for Accessible Design 2010.

B ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.

C ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2021a.

D ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings 2021.

1.04 SUBMITTALS

A See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

C Samples: Submit two, 4 inch long samples of handrail. Submit two samples of elbow, wall bracket, and end stop.

1.05 QUALITY ASSURANCE

A Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A Handrails and Railings:

1. Kane Innovations; [____]: www.kaneinnovations.com/#sle.

2. Kee Safety, Inc; Kee Klamp (steel): www.keesafety.com/#sle.

3. The Wagner Companies; [____]: www.wagnercompanies.com/#sle.

4. Substitutions: See Section 01 60 00 - Product Requirements.

B Accessibility-Compliant Handrail Brackets:

1. Rakks/Rangine Corporation; ADA Compliant HR-202: www.rakks.com/#sle.

2.02 RAILINGS - GENERAL REQUIREMENTS

A Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of applicable local code.

B Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 50 pounds per linear foot applied to the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935

- C Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds applied at any point on the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935
- D Allow for expansion and contraction of members and building movement without damage to connections or members.
- E Dimensions: See drawings for configurations and heights.
- F Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
 - 1. For anchorage to concrete, provide inserts to be cast into concrete, for bolting anchors.
 - 2. For anchorage to stud walls, provide backing plates, for bolting anchors.
- G Provide welding fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

2.03 STEEL RAILING SYSTEM

- A Steel Tube: ASTM A500/A500M Grade B cold-formed structural tubing.
- B Steel Pipe: ASTM A53/A53M Grade B Schedule 80, black finish.
- C Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.

2.04 FABRICATION

- A Accurately form components to suit specific project conditions and for proper connection to building structure.
- B Fit and shop assemble components in largest practical sizes for delivery to site.
- C Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
- D Welded Joints:
 - 1. Exterior Components: Continuously seal joined pieces by intermittent welds and plastic filler. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
 - 2. Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler.
 - 3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A Clean and strip primed steel items to bare metal where site welding is required.
- B Supply items required to be cast into concrete or embedded in masonry with setting templates, for installation as work of other sections.

3.03 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.
- C Install railings in compliance with ADA Standards for accessible design at applicable locations.
- D Anchor railings securely to structure.

- E Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

3.04 TOLERANCES

- A Maximum Variation From Plumb: 1/8 inch per floor level, non-cumulative.
- B Maximum Offset From True Alignment: 1/8 inch.
- C Maximum Out-of-Position: 1/4 inch.

END OF SECTION 05 52 13

SECTION 05 73 11 - DECORATIVE METAL AND GLAZED METAL RAILINGS - VIVA

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Railing and handrail assemblies.
- B Metal railings.

1.02 REFERENCE STANDARDS

- A ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- C ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- D ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes 2017.
- E ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2021.
- F ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing 2021.
- G ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing 2021.
- H ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- I ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength 2022.
- J AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).

1.03 ADMINISTRATIVE REQUIREMENTS

- A Preinstallation Meeting: Schedule and conduct a preinstallation meeting one week before starting work of this section. Attendees shall include, but not be limited to:
 - 1. Contractor.
 - 2. Manufacturer's representative.
 - 3. Architect.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Shop Drawings: Indicate railing system elevations and sections, details of profile, dimensions, sizes, connection attachments, anchorage, size and type of fasteners, and accessories. Indicate anchor and joint locations, transitions, and terminations.
- C Samples: Submit one (1) of each item below for each type and condition shown.
 - 1. Railing: 12-inch long section of handrail showing color, finish and connection detail.
- D Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

1.06 FIELD CONDITIONS

- A Do not install railings until project is enclosed and ambient temperature of space is minimum 65 degrees F and maximum 95 degrees F.
- B Maintain ambient temperature of space at minimum 65 degrees F and maximum 95 degrees F for 24 hours before, during, and after railing installation.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A Viva Railings, LLC: 151 W. Vista Ridge Mall Drive, Lewisville, TX 75067. 972-353-8482.
www.vivarailings.com/#sle.
- B Substitutions: Not permitted.

2.02 RAILING SYSTEMS, GENERAL

- A Factory- or shop-fabricate to suit project conditions, for proper connection to building structure, and in largest practical sizes for delivery to site.
- B Handrails: Comply with applicable accessibility requirements of ADA Standards.
- C Joints: Tightly fitted and secured, machined smooth with hairline seams.
- D Field Connections: Provide sleeves, anchors, and other devices required for site assembly and installation.
- E Welded Joints: Make visible joints butt tight, flush, and hairline; use methods that avoid discoloration and damage of finish; grind smooth, polish, and restore to required finish.

2.03 METAL RAILINGS

- A Metal Railing: Engineered, post-supported railing system.
 - 1. Top Rail and Grip Rail: As indicated on drawings.
 - 2. Handrail Brackets: Same metal as railing.

2.04 MATERIALS AND FINISHES

- A Steel Components:
 - 1. Sections, Shapes, Plates, and Bars: ASTM A36/A36M.
 - 2. Tubing: ASTM A501/A501M structural tubing; round, and shapes as indicated.
 - 3. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, and galvanized to ASTM A153/A153M where connecting galvanized components.
 - 4. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
 - 5. Powder Coat Finish: Manufacturer's recommended system.
- B Stainless Steel Components:
 - 1. ASTM A666, Type 304 or Type 316.
 - 2. Stainless Steel Tubing: ASTM A554, Type 304 or Type 316.
 - 3. Stainless Steel Bars, Shapes, and Moldings: ASTM A276/A276M, Type 304 or Type 316.
 - 4. Stainless Steel Finish: No. 4 Polished, Vertical.

2.05 ACCESSORIES

- A Anchors and Fasteners: Provide anchors and other materials as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable, provide flush countersunk fasteners.
 - 1. For anchorage to concrete, provide inserts to cast into concrete for bolt anchors.
 - 2. For anchorage to masonry, provide brackets to embed in masonry for bolt anchors.
 - 3. For anchorage to stud walls, provide backing plates for bolt anchors.
 - 4. Exposed Fasteners: No exposed bolts or screws.
- B Carbon Steel Bolts and Nuts: ASTM A307.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that substrate and site conditions are acceptable and ready to receive work.
- B Verify field dimensions of locations and areas to receive work.

- C Notify Architect immediately of conditions that would prevent satisfactory installation.
- D Do not proceed with work until detrimental conditions have been corrected.
- E Furnish components to be installed in other work to installer of that other work, including but not limited to blocking, sleeves, inserts, anchor bolts, embedded plates, and supports for attachment of anchors.

3.02 PREPARATION

- A Protect existing work.
- B Review installation drawings before beginning installation. Coordinate diagrams, templates, instructions, and directions for installation of anchorages and fasteners.
- C Clean surfaces to receive units. Remove materials and substances detrimental to the installation.

3.03 INSTALLATION

- A Comply with manufacturer's drawings and written instructions.
- B Install components plumb and level, accurately fitted, free from distortion or defects, and with tight joints, except where necessary for expansion.
- C Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D Anchor securely to structure.
- E Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- F Isolate dissimilar materials with bituminous coating, bushings, grommets, or washers to prevent electrolytic corrosion.

3.04 TOLERANCES

- A Maximum Variation From Plumb: 1/4 inch per floor level, noncumulative.
- B Maximum Offset From True Alignment: 1/4 inch.
- C Maximum Out-of-Position: 1/4 inch.

3.05 CLEANING

- A Metal: Clean exposed metal finishes with potable water and mild detergent, in accordance with manufacturer recommendations; do not use abrasive materials or chemicals, detergents, or other substances that may damage the material or finish.

3.06 PROTECTION

- A Repair damage to exposed finishes to be indistinguishable from undamaged areas.
 - 1. If damage to finishes and components cannot be repaired to be indistinguishable from undamaged finishes and components, replace damaged items.

END OF SECTION 05 73 11

SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Specially fabricated cabinet units.
- B Countertops.
- C Hardware.
- D Preparation for installing utilities.

1.02 RELATED REQUIREMENTS

- A Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B Section 06 10 00 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- C Section 06 61 00 - Cast Polymer Fabrications: Cast plastic countertops.
- D Section 12 36 00 - Countertops.

1.03 REFERENCE STANDARDS

- A ANSI A135.4 - Basic Hardboard 2012 (Reaffirmed 2020).
- B ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications 2022.
- C AWI (QCP) - Quality Certification Program Current Edition.
- D AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- E AWMAC (GIS) - Guarantee and Inspection Services Program Current Edition.
- F AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards 2021, with Errata.
- G BHMA A156.9 - Cabinet Hardware 2020.
- H GSA CID A-A-1936 - Adhesives, Contact, Neoprene Rubber 1996a (Validated 2013).
- I HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood 2020.
- J NEMA LD 3 - High-Pressure Decorative Laminates 2005.
- K UL (DIR) - Online Certifications Directory Current Edition.
- L WI (CCP) - Certified Compliance Program (CCP) Current Edition.
- M WI (CSIP) - Certified Seismic Installation Program (CSIP) Current Edition.
- N WI (MCP) - Monitored Compliance Program (MCP) Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
 - 2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- C Product Data: Provide data for hardware accessories.
- D Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- E Sustainable Design Submittal: Documentation for sustainably harvested wood-based components.

1.06 QUALITY ASSURANCE

- A Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.

2. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
 3. Single Source Responsibility: Provide and install this work from single fabricator.
- B Quality Certification:
1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
 2. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 3. Provide designated labels on shop drawings as required by certification program.
 4. Provide designated labels on installed products as required by certification program.
 5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
 6. Replace, repair, or rework all work for which certification is refused.
- 1.07 MOCK-UPS
- A Provide mock-up of typical base cabinet, wall cabinet, and countertop, including hardware, finishes, and plumbing accessories.
 - B See Section 01 40 00 - Quality Requirements for additional requirements.
 - C Locate where directed.
 - D Mock-up may remain as part of the work.
- 1.08 DELIVERY, STORAGE, AND HANDLING
- A Protect units from moisture damage.
- 1.09 FIELD CONDITIONS
- A During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS

- A Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B Plastic Laminate Faced Cabinets: Custom grade.
- C Cabinets:
 1. Finish - Exposed Exterior Surfaces: Decorative laminate.
 2. Finish - Exposed Interior Surfaces: Decorative laminate.
 3. Finish - Semi-Exposed Surfaces: Decorative laminate
 4. Finish - Concealed Surfaces: Manufacturer's option.
 5. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
 6. Door and Drawer Front Retention Profiles: Fixed panel.
 7. Casework Construction Type: Type A - Frameless.
 8. Interface Style for Cabinet and Door: Style 1 - Overlay; flush overlay.
 9. Grained Face Layout for Cabinet and Door Fronts: Flush panel.
 - a. Custom Grade: Doors, drawer fronts and false fronts wood grain to run and match vertically within each cabinet unit.
 10. Adjustable Shelf Loading: 40 psf.
 - a. Deflection: L/144.
 11. Cabinet Style: Flush overlay.

12. Cabinet Doors and Drawer Fronts: Flush style.
13. Drawer Side Construction: Multiple-dovetailed.
14. Drawer Construction Technique: Dovetail joints.

2.02 WOOD-BASED COMPONENTS

- A Wood fabricated from old growth timber is not permitted.
- B Provide sustainably harvested wood, certified or labeled; see Section 01 60 00.
- C Wood fabricated from timber recovered from riverbeds or otherwise abandoned is permitted, unless otherwise noted, provided it is clean and free of contamination; identify source; provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc.

2.03 PANEL CORE MATERIALS

- A Medium Density Fiberboard (MDF): Composite panel composed of cellulosic fibers, additives, and bonding system; cured under heat and pressure; comply with ANSI A208.2.
 1. Grade: 115; moisture resistance: MR10.
 2. Panel Thickness: 3/4 inch.

2.04 LAMINATE MATERIALS

- A Manufacturers:
 1. Arborite; ColorEdge: www.arborite.com/#sle.
 2. Formica Corporation; [____]: www.formica.com/#sle.
 3. Panolam Industries International, Inc; [____]: www.panolam.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
- C Provide specific types as indicated.
 1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, through color, [____] color, finish as indicated.
 2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, through color, [____] color, finish as indicated.

2.05 COUNTERTOPS

- A Countertops: See Section 12 36 00.

2.06 ACCESSORIES

- A Adhesive: Type recommended by fabricator to suit application.
- B Fasteners: Size and type to suit application.
- C Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- D Concealed Joint Fasteners: Threaded steel.

2.07 HARDWARE

- A Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
- B Metal Z-Shaped Wall Cabinet Support Clips: Paired, cleated, structural anchorage components applied to back of cabinets and walls for wall cabinet mounting.
 1. Material: Extruded Aluminum.
 2. Thickness: [____] inch.
 3. Height: [____] inch.
 4. Stand-Off: [____] inch.
 5. Lift-Off: [____] inch.

6. Width: [____] inches.
7. Products:
 - a. Eagle Mouldings, Inc; Eagle Z-Clips: www.eagle-aluminum.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 3 inch spacing adjustments.
- D Shelf Support Brackets: Fixed, L-shaped, corner reinforced, face-of-stud mounting.
 1. Materials: Formed steel shapes.
 - a. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 - b. Color: Black.
 2. Height: 5 inches.
 3. Support Length: 8 inches.
 4. Products:
 - a. A&M Hardware, Inc; Standard Brackets: www.aandmhardware.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- E Countertop Support Brackets: Fixed, L-shaped, face-of-stud mounting.
 1. Materials: Steel; T-shape cross-section.
 - a. Finish: Manufacturer's standard, factory-applied, powder coat.
 - b. Color: Black.
 - c. Height: 9 inches.
 - d. Support Length: 9 inches.
 - e. Width: 1 inch.
 2. Materials: Steel plates.
 - a. Finish: Manufacturer's standard, factory-applied, black powder coat.
 - b. Height: 9 inches.
 - c. Support Length: 9 inches.
 - d. Thickness and Width: 3/8 inch by 2-1/2 inches.
 3. Products:
 - a. A&M Hardware, Inc; Hybrid Brackets: www.aandmhardware.com/#sle.
 - b. A&M Hardware, Inc; Heavy-Duty Hybrid Brackets: www.aandmhardware.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- F Countertop Brackets; L-shaped, top of knee wall mounting.
 1. Materials: Steel plates.
 2. Finish: Manufacturer's standard, factory-applied, powder coat.
 3. Color: Black.
 4. Height: 6 inches.
 5. Support Length: 6 inches.
 6. Plate Thickness and Width: 3/8 inch by 2-1/2 inches.
 7. Products:
 - a. Centerline Brackets; Standard Granite Countertop Support Bracket: www.countertopbracket.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- G Drawer and Door Pulls: As indicated in Millwork Hardware Schedule in drawings.

- H Cabinet Catches and Latches:
 - 1. Type: Magnetic catch.
 - 2. Manufacturers:
 - a. Knappe & Vogt Manufacturing Company: www.knappeandvogt.com/#sle.
 - b. Rockler Companies, Inc; [____]: www.rockler.com/#sle.
 - c. Sugatsune America, Inc; [____]: www.sugatsune.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
 - I Drawer Slides:
 - 1. Type: Full extension.
 - 2. Static Load Capacity: Commercial grade.
 - 3. Mounting: Side mounted.
 - 4. Stops: Integral type.
 - 5. Features: Provide self closing/stay closed type.
 - 6. Manufacturers:
 - a. Accuride International, Inc; Light-Duty Drawer Slides: www accuride.com/#sle.
 - b. Accuride International, Inc; Heavy-Duty Drawer Slides: www accuride.com/#sle.
 - c. Knappe & Vogt Manufacturing Company; Light-Duty Drawer Slides: www.knappeandvogt.com/#sle.
 - d. Knappe & Vogt Manufacturing Company; Heavy-Duty Drawer Slides: www.knappeandvogt.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
 - J Hinges: European style concealed self-closing type, steel with satin finish.
 - 1. Manufacturers:
 - a. Grass America Inc; [____]: www.grassusa.com/#sle.
 - b. Sugatsune America, Inc; [____]: www.sugatsune.com/#sle.
 - K Soft Close Adapter: Concealed, frame-mounted, screw-adjustable damper; steel with polished finish.
 - 1. Manufacturers:
 - a. Grass America Inc; [____]: www.grassusa.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- 2.08 SHOP TREATMENT OF WOOD MATERIALS
- A Provide UL (DIR) listed and approved identification on fire retardant treated material.
- 2.09 SITE FINISHING MATERIALS
- A Stain, Shellac, Varnish, and Finishing Materials: In compliance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- 2.10 FABRICATION
- A Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
 - B Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
 - C Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
 - D Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.

1. Cap exposed plastic laminate finish edges with material of same finish and pattern.
- E Mechanically fasten back splash to countertops as recommended by laminate manufacturer at 16 inches on center.
- F Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

2.11 SHOP FINISHING

- A Sand work smooth and set exposed nails and screws.
- B For opaque finishes, apply wood filler in exposed nail and screw indentations and sand smooth.
- C On items to receive transparent finishes, use wood filler matching or blending with surrounding surfaces and of types recommended for applied finishes.
- D Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 1. Transparent:
 - a. System - 4, Latex Acrylic, Water-based.
 - b. Stain: As selected by Architect.
 - c. Sheen: Satin.
 - d. Products:
 - 1) Sherwin-Williams Sayerlack Hydroplus Waterborne Clear, AF71 Series, ASI Finishing System 8: www.sherwin-williams.com/#sle.
 - 2) Substitutions: Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify adequacy of backing and support framing.
- B Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION

- A Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- C Use fixture attachments in concealed locations for wall mounted components.
- D Use concealed joint fasteners to align and secure adjoining cabinet units.
- E Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
- F Secure cabinets to floor using appropriate angles and anchorages.
- G Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 ADJUSTING

- A Adjust installed work.
- B Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

- A Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 06 41 00

SECTION 07 21 00 - THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A Board insulation and integral vapor retarder at over roof deck and over roof sheathing.

1.02 RELATED REQUIREMENTS

A Section 07 26 00 - Vapor Retarders: Separate vapor retarder materials.

1.03 REFERENCE STANDARDS

A ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation 2021.

B ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board 2022.

C ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.

1.04 SUBMITTALS

A See Section 01 30 00 - Administrative Requirements for submittal procedures.

B Product Data: Provide data on product characteristics, performance criteria, and product limitations.

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

1.05 FIELD CONDITIONS

A Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.01 APPLICATIONS

A Insulation Over Roof Deck: Polyisocyanurate board providing continuous thermal resistance of R-30 minimum over existing roof deck.

2.02 FOAM BOARD INSULATION MATERIALS

A Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, comply with ASTM C1289.

1. Classifications:

a. Type I: Faced with aluminum foil on both major surfaces of the core foam.

1) Class 1 - Non-reinforced core foam.

2) Compressive Strength: 16 psi, minimum.

3) Thermal Resistance, R-value: At 1-1/2 inch thick; 9.0, minimum, at 75 degrees F.

2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.

3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.

4. Board Size: 48 inch by 96 inch.

5. Board Thickness: 2.5 inch.

6. Tapered Board: Slope as indicated; minimum thickness 5 inch; fabricate of fewest layers possible.

7. Board Edges: Square.

8. Products:

a. Atlas Roofing Corporation; ACFoam-II Polyiso Roof Insulation: www.atlasroofing.com/#sle.

b. Atlas Roofing Corporation; EnergyShield CGF PRO: www.atlasroofing.com/#sle.

c. Johns Manville; AP Foil-Faced: www.jm.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

A Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.

- B Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION OVER LOW SLOPE ROOF DECK

- A Installation of board insulation over low slope roof deck, see Section [_____].

- B Board Installation Over Roof Deck, General:

1. See applicable roofing specification section for specific board installation requirements.
2. Fasten insulation to deck in accordance with roofing manufacturer's written instructions and applicable Factory Mutual requirements.
3. Do not apply more insulation than can be covered with roofing on the same day.

3.03 FIELD QUALITY CONTROL

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

3.04 PROTECTION

- A Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 07 21 00

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- B ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.
- C ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- D ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free 2007 (Reapproved 2018).
- E CDA A4050 - Copper in Architecture - Handbook current edition.
- F SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.

1.02 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- C Samples: Submit two samples, 8" length (each profile), illustrating metal finish color.

1.03 QUALITY ASSURANCE

- A Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Sheet Metal Flashing and Trim Manufacturers:

2.02 SHEET MATERIALS

- A Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal.
- B Pre-Finished Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 18 gauge, 0.040 inch thick; plain finish shop pre-coated with silicone modified polyester coating.

2.03 FABRICATION

- A Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B Form pieces in longest possible lengths.
- C Hem exposed edges on underside 1/2 inch; miter and seam corners.
- D Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E Fabricate corners from one piece with minimum 18-inch long legs; seam for rigidity, seal with sealant.
- F Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.04 GUTTER AND DOWNSPOUT FABRICATION

- A Gutters: SMACNA (ASMM) Rectangular profile.
- B Downspouts: Rectangular profile.
- C Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA (ASMM).
- D Seal metal joints.

2.05 ACCESSORIES

- A Fasteners: Same material and finish as flashing metal.
- B Primer: Zinc chromate type.

- C Concealed Sealants: Non-curing butyl sealant.
- D Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- E Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

PART 3 EXECUTION

3.01 INSTALLATION

- A Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
- B Apply plastic cement compound between metal flashings and felt flashings.
- C Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- D Secure gutters and downspouts in place with concealed fasteners.

END OF SECTION 07 62 00

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- C ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

1.02 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Manufacturer's data sheets on each product to be used.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Maintenance requirements.
- C Warranty Documentation:
 - 1. Submit manufacturer warranty.
 - 2. Ensure that forms have been completed in Owner's name and registered with manufacturer.

1.03 WARRANTY

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B Manufacturer Warranty: Provide 5-year manufacturer warranty for all roof accessories. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 ROOF CURBS

- A Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.
 - 1. Roof Curb Mounting Substrate: Curb substrate consists of standing seam metal roof panel system.
 - 2. Sheet Metal Material:
 - a. Galvanized Steel: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33; G60 coating designation; 18 gauge, 0.048 inch thick.
 - 3. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing system at 1:1 slope; minimum cant height 4 inches.
 - 4. Fabricate curb bottom and mounting flanges for installation directly on metal roof panel system to match slope and configuration of system.
 - a. Extend side flange to next adjacent roof panel seam and comply with seam configurations and seal connection, providing at least 6 inch clearance between curb and metal roof panel flange allowing water to properly flow past curb.
 - b. Where side of curb aligns with metal roof panel flange, attach fasteners on upper slope of flange to curb connection allowing water to flow past below fasteners, and seal connection.
 - c. Maintain at least 12 inch clearance from curb, and lap upper curb flange on underside of down sloping metal roof panel, and seal connection.

- d. Lap lower curb flange overtop of down sloping metal roof panel and seal connection.
 - 5. Provide layouts and configurations indicated on drawings.
 - B Curbs Adjacent to Roof Openings: Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
 - 1. Provide preservative treated wood nailers along top of curb.
 - 2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
 - 3. Height Above Finished Roof Surface: 8 inches, minimum.
 - C Equipment Rail Curbs: Straight curbs on each side of equipment, with top of curbs horizontal and level with each other for equipment mounting.
 - D Pipe, Duct, or Conduit Mounting Curbs: Vertical posts, minimum 8 inches square unless otherwise indicated.
- 2.02 ROOF VENTS
- A Built-Up Roofing Vents: Formed galvanized steel, with watertight construction to allow construction below roof membrane to breathe; with attachment flanges as recommended by manufacturer.
 - 1. Finish: Mill finish.
 - B Frames and Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
 - 1. Material: Galvanized steel, 14 gauge, 0.0747 inch thick.
 - 2. Insulation: Manufacturer's standard; 1 inch rigid glass fiber, located on outside face of curb.
 - 3. Curb Height: 12 inches from finished surface of roof, minimum.
 - C Metal Covers: Flush, insulated, hollow metal construction.
 - 1. Capable of supporting 40 psf live load.
 - 2. Material: Galvanized steel; outer cover 14 gauge, 0.0747 inch thick, liner 22 gauge, 0.03 inch thick.
 - 3. Finish: Factory prime paint.
 - 4. Insulation: Manufacturer's standard 1 inch rigid glass fiber.
 - 5. Gasket: Neoprene, continuous around cover perimeter.
- 2.03 NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES
- A Non-Penetrating Rooftop Support/Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.
 - 1. Design Loadings and Configurations: As required by applicable codes.
 - 2. Support Spacing and Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 3. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - 4. Hardware, Bolts, Nuts, and Washers: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.
 - B Roof Walkways and Platforms: Non-penetrating, mechanically attached walkway system installed over standing seam metal roofs.
 - 1. Dimensions: As indicated on drawings.
 - 2. Grating Length: Manufacturer's standard length.
 - 3. Walking Surfaces: 18 gauge, 0.0478 inch hot dip galvanized steel grating at G90 in accordance with ASTM A653/A653M, either formed plank grating or welded bar grating, with anti-skid surface and handrails at locations indicated on drawings.

4. Provide support plate assemblies and attachment hardware in compliance with manufacturer's written instructions in accordance with installation requirements.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

END OF SECTION 07 72 00

SECTION 07 81 00 - APPLIED FIRE PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Applied fire protection of interior structural steel not exposed to damage or moisture.
- B Preparation of applied fire protection for application of exposed overcoat finish specified elsewhere.

1.02 RELATED REQUIREMENTS

- A Section 05 12 00 - Structural Steel Framing.
- B Section 05 31 00 - Steel Decking.
- C Section 07 84 00 - Firestopping.
- D Section 09 21 16 - Gypsum Board Assemblies: Gypsum board fireproofing.

1.03 REFERENCE STANDARDS

- A ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- B ASTM E605/E605M - Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members 2019.
- C ASTM E736/E736M - Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members 2019.
- D ASTM E760/E760M - Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members 1992 (Reapproved 2020).
- E ASTM E859/E859M - Standard Test Method for Air Erosion of Sprayed Fire-Resistive Materials (SFRMs) Applied to Structural Members 1993 (Reapproved 2020).
- F ASTM E937/E937M - Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members 1993 (Reapproved 2020).
- G UL (FRD) - Fire Resistance Directory Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordinate with placement of ceiling hanger tabs, mechanical component hangers, and electrical components.
- B Preinstallation Meeting: Convene one week before starting work of this section.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittals procedures.
- B Product Data: Provide data indicating product characteristics.
- C Manufacturer's Certificate: Certify that applied fireproofing products meet or exceed requirements of Contract Documents.
- D Test Reports: Reports from reputable independent testing agencies for proposed products, indicating compliance with specified criteria, conducted under conditions similar to those on project, as follows:
 - 1. Bond strength.
 - 2. Bond impact.
 - 3. Compressive strength.
 - 4. Fire tests using substrate materials similar those on project.
- E Field Quality Control Submittals: Submit field test report.
- F Manufacturer Reports: Indicate environmental conditions that applied fireproofing materials were installed.
- G Manufacturer's Qualification Statement.
- H Installer's Qualification Statement.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience

1.07 MOCK-UP

- A Construct mock-up, 100 square feet in size.
- B Comply with project requirements for fire ratings.
- C Locate where directed.
- D Examine installation within one hour of application to determine variances from specified requirements due to shrinkage, temperature, and humidity.
- E Where shrinkage and cracking are evident, adjust mixture and method of application as necessary; remove materials and re-construct mock-up.
- F Mock-up may remain as part of the Work.

1.08 FIELD CONDITIONS

- A Do not apply fireproofing when temperature of substrate material and surrounding air is below 40 degrees F or when temperature is predicted to be below said temperature for 24 hours after application.
- B Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.
- C Provide temporary enclosure to prevent spray from contaminating air.

1.09 WARRANTY

- A See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B Correct defective Work within a two year period after Date of Substantial Completion.
 - 1. Include coverage for fireproofing to remain free from cracking, checking, dusting, flaking, spalling, separation, and blistering.
 - 2. Reinstall or repair failures that occur within warranty period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Applied Fire Protection:
 - 1. GCP Applied Technologies; [____]: www.gcpat.com/#sle.
 - 2. Isolatek International Corp; [____]: www.isolatek.com/#sle.
 - 3. Southwest Fireproofing Products Company; [____]: www.sfrm.com/#sle.

2.02 APPLIED FIRE PROTECTION ASSEMBLIES

- A Provide assemblies as indicated on drawings.
- B Provide a fire rated assembly rating of one hour for typical floor assembly to UL Design No. [____] and two hours for typical floor assembly to UL Design No. [____].
- C Provide fire resistance ratings for following building elements as required by local building code:
 - 1. Primary structural frame, including columns, girders, and trusses, hours.
 - 2. Floor construction, including supporting beams and joists, 1 hour.
 - 3. Floor construction, including supporting beams and joists, 2 hours.
- D Provide UL fire-rated assemblies to hourly ratings as follows:
 - 1. Interior floors: Two hours and one hours
 - 2. Interior beams and joists: Two hours and one hour.

2.03 MATERIALS

- A Applied Fire Protection Material for Interior Applications, Concealed: Manufacturer's standard factory mixed material, which when combined with water is capable of providing indicated fire resistance, and complying with following requirements:
 - 1. Bond Strength: 150 pounds per square foot, minimum, when tested in accordance with ASTM E736/E736M when set and dry.
 - 2. Dry Density: As required by fire resistance design.
 - 3. Compressive Strength: 8.33 pounds per square inch, minimum.
 - 4. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760/E760M.
 - 5. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937/E937M.
 - 6. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.
 - 7. Manufacturers:
 - a. GCP Applied Technologies; Monokote MK-6: www.gcpat.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 ACCESSORIES

- A Primer Adhesive: Of type recommended by applied fire protection manufacturer.
- B Metal Lath: Expanded metal lath; minimum weight of 1.7 psf, galvanized finish.
- C Water: Clean, potable.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that surfaces are ready to receive fireproofing.
- B Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.
- C Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.
- D Verify that voids and cracks in substrate have been filled.
- E Verify that projections have been removed where fireproofing will be exposed to view as a finish material.

3.02 PREPARATION

- A Perform tests as recommended by fireproofing manufacturer in applications where adhesion of fireproofing to substrate is in question.
- B Remove incompatible materials that could effect bond by scraping, brushing, scrubbing, or sandblasting.
- C Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.
- D Apply fireproofing manufacturer's recommended bonding agent on primed steel.
- E Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting.
- F Close off and seal duct work in areas where fireproofing is being applied.

3.03 APPLICATION

- A Install metal lath over structural members as indicated or as required by UL Assembly Design Numbers.
- B Apply primer adhesive in accordance with manufacturer's instructions.
- C Apply fireproofing in uniform thickness and density as necessary to achieve required ratings.

3.04 FIELD QUALITY CONTROL

- A Perform field inspection and testing in accordance with Section 01 40 00 - Quality Requirements.
- B Inspect installed fireproofing after application and curing for integrity, prior to its concealment.
- C Ensure that actual thicknesses, densities, and bond strengths meet requirements for specified ratings and requirements of authorities having jurisdiction (AHJ).
- D Repair or replace applied fireproofing at locations where test results indicate fireproofing does not meet specified requirements.
- E Re-inspect installed fireproofing for integrity of fire protection, after installation of subsequent Work.

3.05 CLEANING

- A Remove excess material, overspray, droppings, and debris.
- B Remove fireproofing from materials and surfaces not required to be fireproofed.

END OF SECTION 07 81 00

SECTION 07 84 00 - FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Firestopping systems.
- B Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED REQUIREMENTS

- A Section 09 21 16 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS

- A ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.
- B ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).
- C ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems 2015 (Reapproved 2019).
- D ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies 2013 (Reapproved 2017).
- E ITS (DIR) - Directory of Listed Products Current Edition.
- F FM (AG) - FM Approval Guide current edition.
- G UL 1479 - Standard for Fire Tests of Penetration Firestops Current Edition, Including All Revisions.
- H UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems Current Edition, Including All Revisions.
- I UL (DIR) - Online Certifications Directory Current Edition.
- J UL (FRD) - Fire Resistance Directory Current Edition.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data on product characteristics, performance ratings, and limitations.

1.05 FIELD CONDITIONS

- A Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
- B Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Firestopping Manufacturers:
 - 1. 3M Fire Protection Products; [____]: www.3m.com/firestop/#sle.
 - 2. A/D Fire Protection Systems Inc; [____]: www.adfire.com/#sle.
 - 3. Hilti, Inc; [____]: www.hilti.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A Firestopping Materials: Any materials meeting requirements.
- B Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- C Fire Ratings: Refer to drawings for required systems and ratings.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
- B Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
 - 2. Listing by UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.
- C Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
 - 1. Listing by UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

2.04 FIRESTOPPING FOR PERIMETER CONTAINMENT

- A Perimeter Joint Systems That Have Movement Capabilities (Dynamic-D):
 - 1. 2 Hour Construction: UL System CW-D-1004; Specified Technologies Inc. AS200 Elastomeric Spray.

2.05 FIRESTOPPING FOR FLOOR-TO-FLOOR, FLOOR-TO-WALL, HEAD-OF-WALL, AND WALL-TO-WALL JOINTS

- A Concrete and Concrete Masonry Walls and Floors:
 - 1. Floor-to-Floor Joints:
 - 2. Head-of-Wall Joints at Concrete/Concrete Masonry Wall to Concrete Over Metal Deck Floor:
- B Gypsum Board Walls:
 - 1. Wall-to-Wall Joints That Have Not Been Tested For Movement Capabilities (Static-S):
 - a. 2 Hour Construction: UL System WW-S-0063; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
 - b. 1 Hour Construction: UL System WW-S-0063; Specified Technologies Inc. SpeedFlex TTG Track Top Gasket.
 - 2. Head-of-Wall Joints at Concrete Over Metal Deck:
 - a. 2 Hour Construction: UL System HW-D-0034; Specified Technologies Inc. ES Elastomeric Firestop Sealant.
 - b. 1 Hour Construction: UL System HW-D-0034; Specified Technologies Inc. ES Elastomeric Firestop Sealant.
 - 3. Head-of-Wall Joints at Concrete Over Metal Deck, Wall Parallel to Ribs:
 - a. 2 Hour Construction: UL System HW-D-0184; Hilti CP 606 Flexible Firestop Sealant.
 - 4. Head-of-Wall Joints at Concrete Over Metal Deck, Wall Perpendicular to Ribs, Cut to Fit Ribs:
 - a. 2 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.
 - b. 1 Hour Construction: UL System HW-D-0045; Hilti CP 606 Flexible Firestop Sealant.

2.06 FIRESTOPPING FOR FLOOR-TO-WALL MOVABLE JOINTS

2.07 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

- A Penetrations Through Floors or Walls By:

1. Multiple Penetrations in Large Openings:
 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 4. Insulated Pipes:
- B Penetrations Through Floors By:
1. Multiple Penetrations in Large Openings:
 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
- C Penetrations Through Walls By:
1. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - b. 1 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.
- 2.08 FIRESTOPPING PENETRATIONS THROUGH FRAMED FLOORS
- 2.09 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS
- A Blank Openings:
1. 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
 2. 1 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
- 2.10 FIRESTOPPING SYSTEMS
- A Firestopping: Any material meeting requirements.
1. Fire Ratings: See drawings for required systems and ratings.
- B Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or less: Any material meeting requirements.
1. Stairway Walls: UL Design No. U419, F Rating 2 hour.
 2. Other Interior Partitions: UL Design No. [____], F Rating 1 & 2 hour.
- C Firestopping at Control Joints (without Penetrations): Any material meeting requirements.
1. Stairway Walls: UL Design No. [____], F Rating 2 hour.
 2. Other Interior Partitions: UL Design No. [____], F Rating 1 & 2 hour.
- PART 3 EXECUTION
- 3.01 EXAMINATION
- A Verify openings are ready to receive the work of this section.
- 3.02 PREPARATION
- A Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B Remove incompatible materials that could adversely affect bond.
- 3.03 INSTALLATION
- A Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B Install labeling required by code.
- 3.04 CLEANING
- A Clean adjacent surfaces of firestopping materials.

END OF SECTION 07 84 00

SECTION 07 92 00 - JOINT SEALANTS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A ASTM C834 - Standard Specification for Latex Sealants 2017.
- B ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications 2022.
- C ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- D ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.

PART 2 PRODUCTS

2.01 JOINT SEALANT APPLICATIONS

- A Scope:
 - 1. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
 - 1) Exception: Through-penetrations in sound-rated assemblies that are also fire-rated.
 - c. Other joints indicated below.
- B Type [___] - Interior Joints: Use nonsag polyurethane sealant, unless otherwise indicated.
 - 1. Type [___] - In Sound-Rated Assemblies: Acrylic emulsion latex sealant.
- C Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.02 JOINT SEALANTS - GENERAL

- A Colors: Match adjacent construction, unless otherwise noted.

2.03 NONSAG JOINT SEALANTS

- A Type [___] - Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus [___] percent, minimum.
- B Type [___] - Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B Provide joint sealant installations complying with ASTM C1193.
- C Install acoustical sealant application work in accordance with ASTM C919.
- D Install bond breaker backing tape where backer rod cannot be used.
- E Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- F Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- G Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Non-fire-rated hollow metal doors and frames.
- B Hollow metal frames for wood doors.
- C Fire-rated hollow metal doors and frames.
- D Sound-rated hollow metal doors and frames.
- E Commercial security hollow metal doors and frames.
- F Detention security hollow metal doors and frames.
- G Bullet-resistant hollow metal doors and frames.
- H Hollow metal borrowed lites glazing frames.
- I Accessories, including glazing, louvers, and matching panels.

1.02 RELATED REQUIREMENTS

- A Section 08 34 73 - Sound Control Door Assemblies.
- B Section 08 71 00 - Door Hardware.
- C Section 08 80 00 - Glazing: Glass for doors and borrowed lites.
- D Section 09 91 23 - Interior Painting: Field painting.

1.03 ABBREVIATIONS AND ACRONYMS

- A ANSI: American National Standards Institute.
- B ASCE: American Society of Civil Engineers.
- C HMMA: Hollow Metal Manufacturers Association.
- D NAAMM: National Association of Architectural Metal Manufacturers.
- E NFPA: National Fire Protection Association.
- F SCIF: Sensitive Compartmented Information Facility.
- G SDI: Steel Door Institute.
- H UL: Underwriters Laboratories.

1.04 REFERENCE STANDARDS

- A ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames 2019.
- C ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors 2018.
- D ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames 2020.
- E ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100) 2017.
- F ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames 2020.
- G ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- H ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip 2022.
- I ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.

- J ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- K ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021a.
- L ASTM A1011/A1011M - 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 2018a.
- M ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete 2020.
- N ASTM C476 - Standard Specification for Grout for Masonry 2020.
- O ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- P ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).
- Q ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference 2014 (Reapproved 2021).
- R ASTM E336 - Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings 2020.
- S ASTM E413 - Classification for Rating Sound Insulation 2022.
- T ASTM E1332 - Standard Classification for Rating Outdoor-Indoor Sound Attenuation 2022.
- U ASTM F1450 - Standard Test Methods for Hollow Metal Swinging Door Assemblies for Detention and Correctional Facilities 2012a (Reapproved 2019).
- V ASTM F2247 - Standard Test Method for Metal Doors Used in Blast Resistant Applications (Equivalent Static Load Method) 2018.
- W ASTM F2927 - Standard Test Method for Door Systems Subject to Airblast Loadings 2021.
- X BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames 2016.
- Y FBC TAS 201 - Impact Test Procedures; Testing Application Standard 1994.
- Z FBC TAS 202 - Criteria for Testing Impact and Non-Impact Resistant Building Envelope Components Using Uniform Static Air Pressure; Testing Application Standard 1994.
- AA FBC TAS 203 - Criteria for Testing Products Subject To Cyclic Wind Pressure Loading; Testing Application Standard 1994.
- BB FLA (PAD) - Florida Building Code Online - Product Approval Directory Current Edition.
- CC ICC 500 - ICC/NSSA Standard for the Design and Construction of Storm Shelters 2020.
- DD ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- EE IEEE 299 - IEEE Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures 2006 (Reaffirmed 2012).
- FF ITS (DIR) - Directory of Listed Products Current Edition.
- GG NAAMM HMMA 805 - Recommended Selection and Usage Guide for Hollow Metal Doors and Frames 2012.
- HH NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames 2002.
- II NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames 2011.
- JJ NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames 2017.
- KK NAAMM HMMA 850 - Fire-Rated Hollow Metal Doors and Frames 2014.
- LL NAAMM HMMA 860 - Guide Specifications for Hollow Metal Doors and Frames 2018.

- MM NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames 2014.
- NN NAAMM HMMA 862 - Guide Specifications for Forced Entry/Bullet Resistant (FE/BR) Security Hollow Metal Doors and Frames 2021.
- OO NAAMM HMMA 865 - Guide Specifications for Sound Control Hollow Metal Door and Frames Assemblies 2013.
- PP NAAMM HMMA 866 - Guide Specifications for Stainless Steel Hollow Metal Doors and Frames 2012 (Reapproved 2018).
- QQ NAAMM HMMA 867 - Guide Specifications for Laminated Core Hollow Metal Doors and Frames 2016.
- RR NCSC (TS) - Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities 2021.
- SS NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2022.
- TT NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives 2022.
- UU NFPA 252 - Standard Methods of Fire Tests of Door Assemblies 2022.
- VV SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames 2019.
- WW UFC 4-010-01 - DoD Minimum Antiterrorism Standards for Buildings 2018, with Editorial Revision (2022).
- XX UL (DIR) - Online Certifications Directory Current Edition.
- YY UL 10B - Standard for Fire Tests of Door Assemblies Current Edition, Including All Revisions.
- ZZ UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies Current Edition, Including All Revisions.
- AAA UL 752 - Standard for Bullet-Resisting Equipment Current Edition, Including All Revisions.
- BBB UL 1784 - Standard for Air Leakage Tests of Door Assemblies Current Edition, Including All Revisions.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- C Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- D Manufacturer's Certificate: Certification that products meet or exceed specified requirements.
- E Installer's Qualification Statement.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- C Maintain at project site copies of reference standards relating to installation of products specified.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Hollow Metal Doors and Frames:

1. Ceco Door, an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. Curries, an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
3. Steelcraft, an Allegion brand; [____]: www.allegion.com/#sle.
4. Titan Metal Products, Inc; Builders Series 20 - 90 Minute Doors: www.titanmetalproducts.com/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B Sound-Rated Hollow Metal Doors and Frames:

1. AMBICO Limited; [____]: www.ambico.com/#sle.
2. Megamet Industries, Inc; MegaSonic 2A-B - Series Flush Doors: www.megametusa.com/#sle.
3. Overly Door Company; [____]: www.overly.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

C Bullet-Resistant, Commercial Security, and Detention Security Hollow Metal Doors and Frames:

1. AMBICO Limited; [____]: www.ambico.com/#sle.
2. Fleming Door Products, an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
3. Krieger Specialty Products; Bullet Resistant Doors: www.kriegerproducts.com/#sle.
4. Megamet Industries, Inc; MegaSafe Ballistic Doors: www.megametusa.com/#sle.
5. Mesker, dormakaba Group; BR Series Bullet-Resistant Doors and Frames: www.meskeropeningsgroup.com/#sle.
6. Republic Doors, an Allegion brand; [____]: www.republicdoor.com/#sle.
7. Security Metal Products Corporation, an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
8. Overly Door Company; [____]: www.overly.com/#sle.
9. Titan Metal Products, Inc; Ballistic Rated Doors and Frames: www.titanmetalproducts.com/#sle.
10. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

A Requirements for Hollow Metal Doors and Frames:

1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
2. Accessibility: Comply with ICC A117.1 and ADA Standards.
3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
4. Door Edge Profile: Manufacturers standard for application indicated.
5. Typical Door Face Sheets: Flush.
6. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
7. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

B Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

A Door Finish: Factory primed and field finished.

- B Type [___], Interior Doors, Non-Fire-Rated:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 2. Door Thickness: 1-3/4 inches, nominal.
 3. Door Finish: Factory primed and field finished.
- C Type [___], Fire-Rated Doors:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
 3. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - a. Attach fire rating label to each fire rated unit.
 4. Smoke and Draft Control Doors (Indicated with letter "S" on Drawings and/or Door Schedule): Self-closing or automatic closing doors in accordance with NFPA 80 and NFPA 105, with fire-resistance-rated wall construction rated the same or greater than the fire-rated doors, and the following;
 - a. Maximum Air Leakage: 3.0 cfm/sq ft of door opening at 0.10 inch w.g. pressure, when tested in accordance with UL 1784 at both ambient and elevated temperatures.
 - b. Gasketing: Provide gasketing or edge sealing as necessary to achieve leakage limit.
 - c. Label: Include the "S" label on fire-rating label of door.
 5. Door Core Material: Manufacturers standard core material/construction in compliance with requirements.
 6. Door Thickness: 1-3/4 inches, nominal.
 7. Door Finish: Factory primed and field finished.
- D Sound Control Door Assemblies: Refer to Section 08 34 73.
- E Type [___], Sound-Rated Interior Doors:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 2. Sound Transmission Class (STC) Rating of Door and Frame Assembly: STC of 39, minimum, calculated in accordance with ASTM E413, and tested in accordance with ASTM E90.
 3. Door Core Material: Manufacturer's standard construction as required to meet acoustic requirements indicated.
 4. Door Thickness: As required to meet acoustic requirements indicated.
 5. Door Finish: Factory primed and field finished.
 6. Opening Force of Sound-Rated Doors, Non-Fire-Rated: 5 pounds, maximum, in compliance with ADA Standards.

- F Type [___], Commercial Security, Detention Security, and Bullet-Resistant Doors; Interior:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch, minimum.
 2. Commercial Security Rating Impact Testing: Comply with forced entry, static load, and soft or hard body impact testing for Class 1 in accordance with NAAMM HMMA 862 requirements.
 3. Bullet Resistance: UL 752, Threat Level Rating - Level 7.
 4. Door Core Material: Manufacturers standard core material/construction in compliance with requirements.
 5. Door Thickness: As required to meet requirements indicated.
 6. Door Finish: Factory primed and field finished.
 7. Hinge Rail and Reinforcement: Non-beveled edge, reinforced with continuous steel channel, 12 gauge, 0.093 inch minimum metal thickness, welded at 5 inch on center maximum, and compatible with 4-1/2 inch full mortise template and continuous geared hinges.

2.04 HOLLOW METAL FRAMES

- A Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B Frame Finish: Factory primed and field finished.
- C Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
1. Terminated Stops: Provide at interior doors; closed end stop terminated 6 inch, maximum, above floor at 45 degree angle.
 2. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 3. Frame Finish: Factory primed and field finished.
- D Door Frames, Fire-Rated: Full profile/continuously welded type.
1. Fire Rating: Same as door, labeled.
 2. Terminated Stops: Provide at interior doors; closed end stop terminated 6 inch, maximum, above floor at 45 degree angle.
 3. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 4. Frame Finish: Factory primed and field finished.
- E Sound-Rated Door Frames: Knock-down type.
1. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 2. Frame Finish: Factory primed and field finished.
- F Bullet-Resistant Door Frames: Comply with UL 752, with same level of bullet resistance as door; face welded construction, ground smooth, fully prepared and reinforced for hardware installation.
1. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
 2. Frame Finish: Factory primed and field finished.
- G Commercial and/or Detention Security-Resistant Door Frames: With same security resistance as door; face welded or full profile/continuously welded construction, ground smooth, fully prepared and reinforced for hardware installation.
- H Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- I Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.

- J Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
- K Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.

2.05 FINISHES

- A Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES

- A Louvers: Roll formed steel with overlapping frame; finish same as door components ; factory-installed.
 - 1. In Fire-Rated Doors: UL (DIR) or ITS (DIR) listed fusible link louver, same rating as door.
 - 2. Style: Standard straight slat blade.
 - 3. Louver Free Area: [____] percent.
 - 4. Fasteners: Exposed or concealed fasteners.
- B Door Window Frames: Door window frames with glazing securely fastened within door opening.
 - 1. Size: As indicated on drawings.
 - 2. Frame Material: 18 gauge, 0.0478 inch, galvanized steel.
 - 3. Metal Finish: Dark Bronze polyester powder coating.
- C Glazing: As specified in Section 08 80 00, factory installed.
- D Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.
- E Astragals and Edges for Double Doors: Pairs of door astragals, and door edge sealing and protection devices.
 - 1. UL listed products in compliance with requirements of authorities having jurisdiction.
 - 2. Provide surface mounted astragal to cover or fill space for full door height between pair of doors or door and adjacent jamb.
 - 3. Astragal Type: Split, two parts, and with automatic locking, cutouts for other door hardware, and sealing gasket.
 - 4. Edge Type: Beveled edge
 - 5. Material: Aluminum.
 - 6. Metal Finish: Dark Bronze powder coating.
 - 7. Provide non-corroding fasteners at exterior locations.
- F Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.
- G Grout for Frames: Mortar grout complying with ASTM C476 with maximum slump of 4 inches as measured in accordance with ASTM C143/C143M for hand troweling in place; plaster grout and thinner pumpable grout are prohibited.
- H Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- I Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify existing conditions before starting work.
- B Verify that opening sizes and tolerances are acceptable.
- C Verify that finished walls are in plane to ensure proper door alignment.

3.02 PREPARATION

- A Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 INSTALLATION

- A Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B Install fire rated units in accordance with NFPA 80.
- C Coordinate frame anchor placement with wall construction.
- D Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- E Install door hardware as specified in Section 08 71 00.
 - 1. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.
- F Comply with glazing installation requirements of Section 08 80 00.
- G Coordinate installation of electrical connections to electrical hardware items.
- H Touch up damaged factory finishes.

3.04 TOLERANCES

- A Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.05 ADJUSTING

- A Adjust for smooth and balanced door movement.
- B Adjust sound control doors so that seals are fully engaged when door is closed.
- C Test sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

3.06 SCHEDULE

- A Refer to Door and Frame Schedule on the drawings.

END OF SECTION 08 11 13

SECTION 08 14 16 - FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Flush wood doors; flush and flush glazed configuration; fire-rated, non-rated, and acoustical

1.02 RELATED REQUIREMENTS

- A Section 08 11 13 - Hollow Metal Doors and Frames.
- B Section 08 12 13 - Hollow Metal Frames.
- C Section 08 71 00 - Door Hardware.
- D Section 08 80 00 - Glazing.
- E Section 09 93 00 - Staining and Transparent Finishing: Field finishing of doors.

1.03 REFERENCE STANDARDS

- A 16 CFR 1201 - Safety Standard for Architectural Glazing Materials Current Edition.
- B ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- C ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).
- D ASTM E413 - Classification for Rating Sound Insulation 2022.
- E AWI (QCP) - Quality Certification Program Current Edition.
- F AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- G AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards 2021, with Errata.
- H NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2022.
- I NFPA 252 - Standard Methods of Fire Tests of Door Assemblies 2022.
- J UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
 - 1. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- D Samples: Submit two samples of door veneer, 6 by 6 inches in size illustrating wood grain, stain color, and sheen.
- E Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- F Test Reports: Show compliance with specified requirements for the following:
 - 1. Sound-retardant doors and frames; sealed panel tests are not acceptable.
- G Manufacturer's qualification statement.
- H Installer's qualification statement.
- I Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

- A Maintain one copy of the specified door quality standard on site for review during installation and finishing.
- B Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.
 - 1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.

- C Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.
- D Woodwork Quality Assurance Program:
 - 1. Comply with AWI (QCP) woodwork association quality assurance service/program in accordance with requirements for work specified in this section; www.awiqcp.org/#sle.
 - 2. Provide labels indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 3. Provide designated labels on shop drawings as required by quality assurance program.
 - 4. Provide designated labels on installed products as required by quality assurance program.
 - 5. Submit documentation upon completion of installation that verifies this work is in compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A Package, deliver and store doors in accordance with specified quality standard.
- B Accept doors on site in manufacturer's packaging, and inspect for damage.
- C Protect doors with resilient packaging sealed with heat shrunk plastic; do not store in damp or wet areas or areas where sunlight might bleach veneer; seal top and bottom edges with tinted sealer if stored more than one week, and break seal on site to permit ventilation.

1.07 WARRANTY

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B Interior Doors: Provide manufacturer's warranty for the life of the installation.
- C Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Wood Veneer Faced Doors:
 - 1. Masonite Architectural; Aspiro Select Wood Veneer Doors: www.architectural.masonite.com/#sle.
 - 2. VT Industries, Inc; [____]: www.vtindustries.com/#sle.
 - 3. Eggers.

2.02 DOORS AND PANELS

- A Doors: See drawings for locations and additional requirements.
 - 1. Quality Standard: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
 - 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
- B Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 - 1. Provide solid core doors at each location.
 - 2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.
 - 3. Sound-Rated Doors: Minimum STC of 31, calculated in accordance with ASTM E413, tested in accordance with ASTM E90.
 - 4. Wood veneer facing for field transparent finish as indicated on drawings.

2.03 DOOR AND PANEL CORES

- A Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.

- B Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.
- C Sound-Rated Doors: Equivalent to type, with particleboard core (PC) construction as required to achieve STC rating specified; plies and faces as indicated above.

2.04 DOOR FACINGS

- A Veneer Facing for Transparent Finish: Maple, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.

2.05 DOOR CONSTRUCTION

- A Fabricate doors in accordance with door quality standard specified.
- B Cores Constructed with stiles and rails:
 - 1. Provide solid blocks at lock edge and top of door for closer for hardware reinforcement.
- C Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
- D Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- E Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- F Provide edge clearances in accordance with the quality standard specified.

2.06 FINISHES - WOOD VENEER DOORS

- A Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 - 1. Transparent:
 - a. System - 1, Lacquer, Nitrocellulose.
 - b. Stain: As selected by Architect.
 - c. Sheen: Flat.
- B Factory finish doors in accordance with approved sample.

2.07 ACCESSORIES

- A Hollow Metal Door Frames: See Section 08 11 13.
- B Glazed Openings:
 - 1. Heat-Strengthened and Fully Tempered Glass: ASTM C1048.
 - 2. Fire-Protection-Rated Glass: Safety Certification, 16 CFR 1201, Category II.
 - 3. Glazing: Single vision units, 1/4 inch thick glass.
- C Glazing: See Section 08 80 00.
- D Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.
- E Door Hardware: See Section 08 71 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify existing conditions before starting work.
- B Verify that opening sizes and tolerances are acceptable.
- C Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

- A Install doors in accordance with manufacturer's instructions and specified quality standard.

1. Install fire-rated doors in accordance with NFPA 80 requirements.
 - B Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
 - C Use machine tools to cut or drill for hardware.
 - D Coordinate installation of doors with installation of frames and hardware.
 - E Coordinate installation of glazing.
- 3.03 TOLERANCES
- A Comply with specified quality standard for fit and clearance tolerances.
 - B Comply with specified quality standard for telegraphing, warp, and squareness.
- 3.04 ADJUSTING
- A Adjust doors for smooth and balanced door movement.
 - B Adjust closers for full closure.

END OF SECTION 08 14 16

SECTION 08 31 00 - ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A Wall- and ceiling-mounted access units.

1.02 RELATED REQUIREMENTS

A Section 09 91 23 - Interior Painting: Field paint finish.

1.03 SUBMITTALS

A See Section 01 30 00 - Administrative Requirements for submittal procedures.

B Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

C Shop Drawings: Indicate exact position of each access door and/or panel unit.

1.04 QUALITY ASSURANCE

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

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

PART 2 PRODUCTS

2.01 ACCESS DOORS AND PANELS ASSEMBLIES

A Fire-Rated Ceiling-Mounted Units:

1. Ceiling Fire-Rating: As indicated on drawings.
2. Size: 12 by 12 inches.

2.02 WALL- AND CEILING-MOUNTED ACCESS UNITS

A Manufacturers:

1. Babcock-Davis; [____]: www.babcockdavis.com/#sle.
2. Best Access Doors: www.bestaccessdoors.com/#sle.
3. Milcor, Inc; [____]: www.milcorinc.com/#sle.

B Wall- and Ceiling-Mounted Units: Factory-fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.

1. Material: Steel.
2. Door Style: Single thickness with rolled or turned in edges.
3. Frames: 16 gauge, 0.0598 inch, minimum thickness.
4. Door Panels to Receive Wall/Ceiling Finish: Surface recessed 5/8 inch back from wall face.
5. Units in Fire-Rated Assemblies: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
6. Steel Finish: Primed.
7. Primed and Factory Finish: Polyester powder coat; color [____].
8. Hardware:
 - a. Hardware for Fire-Rated Units: As required for listing.
 - b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
 - c. Latch/Lock: Screw driver slot for quarter turn cam latch.

PART 3 EXECUTION

3.01 EXAMINATION

A Verify that rough openings are correctly sized and located.

- B Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A Clean surfaces thoroughly prior to proceeding with this work.
- B Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

- A Install units in accordance with manufacturer's instructions.
- B Install frames plumb and level in openings, and secure units rigidly in place.
- C Position units to provide convenient access to concealed equipment when necessary.

END OF SECTION 08 31 00

SECTION 08 43 13 - ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Aluminum-framed storefront, with vision glass. For interior application.
- B Infill panels of glass.
- C Aluminum doors and frames.
- D Weatherstripping.
- E Door hardware.

1.02 RELATED REQUIREMENTS

- A Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.
- B Section 08 80 00 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site 2015.
- B AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document) 2015.
- C AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2021, with Errata (2022).
- D ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- E ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- F ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2019.
- G ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference 2014 (Reapproved 2021).

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordinate with installation of other adjacent components.
- B Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
- C Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- D Samples: Submit two samples 6x6 inches in size illustrating finished aluminum surface, glass, infill panels, glazing materials.
- E Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- F Specimen warranty.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.
- B Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.07 MOCK-UPS

- A See Section 01 40 00 - Quality Requirements for additional requirements.
- B Locate where directed.
- C Mock-up may remain as part of work.

1.08 DELIVERY, STORAGE, AND HANDLING

- A Handle products of this section in accordance with AAMA CW-10.
- B Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.09 FIELD CONDITIONS

- A Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.10 WARRANTY

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Aluminum-Framed Storefronts:
 - 1. Kawneer North America; [____]: www.kawneer.com/#sle.
 - 2. Oldcastle BuildingEnvelope; [____]: www.oldcastlebe.com/#sle.
 - 3. Tubelite, Inc; [____]: www.tubeliteinc.com/#sle.

2.02 BASIS OF DESIGN -- SWINGING DOORS

- A Medium Stile, Monolithic Glazing:
 - 1. Thickness: 1-3/4 inches.

2.03 ALUMINUM-FRAMED STOREFRONT

- A Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Glazing Rabbet: For 1/4 inch monolithic glazing.
 - 2. Glazing Position: Centered (front to back).
 - 3. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
 - 4. Finish: High performance organic coatings.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
 - 5. Finish Color: Brown/Black to match existing storefront color.
 - 6. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 7. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.

8. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
9. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
10. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
11. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B Performance Requirements

1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
2. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.

2.04 COMPONENTS

A Aluminum Framing Members: Tubular aluminum sections.

1. Framing members for interior applications need not be thermally broken.
2. Glazing Stops: Flush.

B Glazing: See Section 08 80 00.

C Swing Doors: Glazed aluminum.

1. Thickness: 1-3/4 inches.
2. Top Rail: 4 inches wide.
3. Vertical Stiles: 4-1/2 inches wide.
4. Bottom Rail: 10 inches wide.
5. Glazing Stops: Square.
6. Finish: Same as storefront.

2.05 MATERIALS

A Extruded Aluminum: ASTM B221 (ASTM B221M).

B Fasteners: Stainless steel.

C Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.06 FINISHES

A High Performance Organic Coating: AAMA 2604; multiple coats, thermally cured fluoropolymer system.

B Color: [_____]Brown/Black to match existing.

2.07 HARDWARE

A For each door, include associated hardware as specified in drawings and in Section 08 71 00.

B Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.

C Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.

D Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify dimensions, tolerances, and method of attachment with other work.
- B

3.02 INSTALLATION

- A Install wall system in accordance with manufacturer's instructions.
- B Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C Provide alignment attachments and shims to permanently fasten system to building structure.
- D Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E
- F
- G
- H
- I Set thresholds in bed of sealant and secure.
- J Install hardware using templates provided.
- K Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- A Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.
- B Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 ADJUSTING

- A Adjust operating hardware and sash for smooth operation.

3.05 CLEANING

- A Remove protective material from pre-finished aluminum surfaces.
- B Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.06 PROTECTION

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

END OF SECTION 08 43 13

SECTION 08 44 13 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Aluminum-framed curtain wall, with vision glazing and glass spadrel panels.
- B Firestopping between curtain wall and edge of floor slab.

1.02 RELATED REQUIREMENTS

- A Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.
- B Section 08 43 13 - Aluminum-Framed Storefronts: Entrance framing and doors.
- C Section 08 80 00 - Glazing.

1.03 REFERENCE STANDARDS

- A AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site 2015.
- B AAMA 501.1 - Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure 2017.
- C AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document) 2015.
- D AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum 2020.
- E AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections 2009.
- F AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2021, with Errata (2022).
- G ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- H ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- I ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- J ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants 2018 (Reapproved 2022).
- K ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems 2016.
- L ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2019.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordinate with installation of other components that comprise the exterior enclosure.
- B Preinstallation Meeting: Conduct a preinstallation meeting upon acceptance of alternate before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, internal drainage details, glazing, [____], and infill.
- C Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

- D Shop Drawings: Provide details of proposed structural sealant glazing (SSG) and weather sealant joints indicating dimensions, materials, bite, thicknesses, profile, and support framing.
- E Samples: Submit two samples 12 x 12 inches in size illustrating finished aluminum surface, glazing, infill panels, and glazing materials.
- F Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure.
- G Test Reports: Submit results of full-size mock-up testing. Reports of tests previously performed on the same design are acceptable.
- H Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
- I Manufacturer's Qualification Statement.
- J Installer's Qualification Statement.
- K Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than five years of documented experience.
 - 1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
 - a. Insulating Glass Certification Council (IGCC).
- B Installer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.

1.07 MOCK-UPS

- A See Section 01 40 00 - Quality Requirements for additional requirements.
- B Provide 8 x 10 feet mock-up including each component being used on the project. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.
- C Locate on-site where directed by Architect; mock-up may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

- A Handle products of this section in accordance with AAMA CW-10.
- B Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.09 FIELD CONDITIONS

- A Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.10 WARRANTY

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- C Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Glazed Aluminum Curtain Walls Manufacturers:

1. Kawneer North America; 1600: www.kawneer.com/#sle.
2. Oldcastle Building Envelope; Reliance: www.oldcastlebe.com/#sle.
3. EFCO; 5600: <https://www.efcocorp.com/>.

2.02 CURTAIN WALL

- A Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
1. Inside glazed, with pressure plate and mullion cover, where indicated on drawings. Coordinate with alternates.
 2. Fabrication Method: Field fabricated stick system.
 3. Glazing Method: Field glazed system.
 4. Finish: High performance organic coatings.
 - a. Factory finish surfaces that will be exposed in completed assemblies.
 - b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
 - c. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
 5. Provide flush joints and corners, weathersealed, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 6. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 7. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 8. Maintain continuous air barrier and/or vapor retarder seal throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.
- B Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
1. Design Wind Loads: Comply with the requirements of ASCE 7
 2. Movement: Accommodate the following movement without damage to components or deterioration of seals:
 - a. Expansion and contraction caused by 180 degrees F surface temperature.
 - b. Expansion and contraction caused by cycling temperature range of 170 degrees F over a 12 hour period.
 - c. Movement of curtain wall relative to perimeter framing.
 - d. Deflection of structural support framing, under permanent and dynamic loads.
- C Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on indoor face when tested as follows:
1. Test Pressure Differential: 10 psf.
- D Air Leakage: 0.06 cfm/sq ft maximum leakage of wall area when tested in accordance with ASTM E283/E283M at 6.27 psf pressure difference across assembly.

2.03 COMPONENTS

- A Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
1. Cross-Section: 2.5 x 6 inch nominal dimension.

B Glazing: See Section 08 80 00.

2.04 MATERIALS

A Extruded Aluminum: ASTM B221 (ASTM B221M).

B Weatherseal Sealant: Silicone, with adhesion in compliance with ASTM C794; compatible with glazing accessories.

C Sill Flashing Sealant: Elastomeric, silicone or polyurethane, and compatible with flashing material.

D Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

E Glazing Accessories: See Section 08 80 00.

2.05 FINISHES

A High Performance Organic Coatings: AAMA 2604; multiple coats, thermally cured fluoropolymer system.

PART 3 EXECUTION

3.01 EXAMINATION

A Verify dimensions, tolerances, and method of attachment with other related work.

B Verify that curtain wall openings and adjoining water-resistive and air barrier seal materials are ready to receive work of this section.

C Verify that anchorage devices have been properly installed and located.

3.02 INSTALLATION

A Install curtain wall system in accordance with manufacturer's instructions.

B Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C Provide alignment attachments and shims to permanently fasten system to building structure.

D Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E Provide thermal isolation where components penetrate or disrupt building insulation.

F Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.

B Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

C Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.04 CLEANING

A Remove protective material from pre-finished aluminum surfaces.

B Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, take care to remove dirt from corners, and wipe surfaces clean.

C Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.05 PROTECTION

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

END OF SECTION 08 44 13

SECTION 08 71 00 - DOOR HARDWARE

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. Mechanical door hardware for the following:
 - a. Swinging doors.
 - b. Lead-lined Swinging doors.

- B. Related Requirements:

- 1. Section 081113 "Hollow Metal Doors and Frames".
- 2. Section 133419 "Metal Building Systems" for door hardware, including cylinders.
- 3. Section 134900 "Radiation Protection" for lead-lined astragals provided as part of labeled fire-rated assemblies.

1.3 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

1.4 ACTION SUBMITTALS

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

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
 3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
 - e. Fastenings and other installation information.
 - f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
 - g. Mounting locations for door hardware.
 - h. List of related door devices specified in other Sections for each door and frame.
- C. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.5 INFORMATIONAL SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware and keying schedule.

1.6 QUALITY ASSURANCE

- A. Supplier Qualifications: The hardware supplier shall be a corporate member in good standing of The Door and Hardware Institute (DHI), employing at least one Architectural Hardware Consultant (AHC) who is currently participating in DHI's continuing education program (CEP).
- B. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
 1. Warehousing Facilities: In Project's vicinity.
 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
- C. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Manufacturers' standard warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from preapproved list of manufacturers only.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
- B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 - 1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.
- C. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and Illinois Accessibility Code (IAC).

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
 - b. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

2.3 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames. All hinges shall be mortised with the door. Doors greater than 84 inches in height shall use 4 hinges per door. Doors equal to or greater than 42 inches in width shall use 4 hinges per door.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. IVES Hardware; an Allegion company.

2.4 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
 2. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.
 3. Deadbolts: Minimum 1-inch (25-mm) throw.
- C. Lock Backset: 2-3/4 inches (70 mm) unless otherwise indicated.
- D. Lock Trim:
 1. Description: As indicated in door hardware schedule.
- E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

F. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Schlage, an Allegion Company. (No Substitutions)

2.5 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

A. Automatic Flush Bolts: BHMA A156.3, Type 25; minimum 3/4-inch (19-mm) throw; with dust-proof strikes; designed for mortising into door edge.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. IVES Hardware; an Allegion company.
 - b. Architectural Builders Hardware

2.6 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Schlage; an Allegion company. (No Substitutions)

2.7 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.

1. New Master Key System:
 - a. Master key or grand master key locks to Owner's requirements.

B. Keys: Nickel Silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: Information to be furnished by Owner.

2.8 ACCESSORIES FOR PAIRS OF DOORS

- A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.
- B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
- C. Astragals: BHMA A156.22.

2.9 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. LCN Closers; an Allegion company. (No Substitutions)

2.10 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16; stainless steel base metal.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. IVES Hardware; an Allegion company.
 - b. Rockwood; an ASSA Abloy company.

2.11 OVERHEAD STOPS AND HOLDERS

- A. Overhead Stops and Holders: BHMA A156.8.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Glynn-Johnson; an Allegion company.
 - b. Architectural Builders Hardware

2.12 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- (1.3-mm-) thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Hager Companies.
- b. IVES Hardware; an Allegion company.
- c. Rockwood Manufacturing Company.

2.13 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hager Companies.
 - b. IVES Hardware; an Allegion company.
 - c. Rockwood Manufacturing Company.

2.14 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.

- 1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

- 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Fire-Rated Applications:

a. Wood or Machine Screws: For the following:

- 1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames.
- 2) Strike plates to frames.
- 3) Closers to doors and frames.

b. Steel Through Bolts: For the following unless door blocking is provided:

- 1) Surface hinges to doors.

- 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.
3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.15 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in

another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).
- E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
1. Replace construction cores with permanent cores as directed by Owner.
 2. Furnish permanent cores to Owner for installation.
- F. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
 2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.

- B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

- A. Engage Installer to train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

3.9 DOOR HARDWARE SCHEDULE

SET 01

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	ENTRANCE LOCK	ND53 x RHO	626	SCH
1	EA	WALL STOP	WS407	630	IVE

SET 02

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	CLASSROOM LOCK	ND70 x RHO	626	SCH
1	EA	CLOSER	4040XP H	689	LCN
1	EA	WALL STOP	WS407	630	IVE

SET 03

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	CLASSROOM LOCK	ND70 x RHO	626	SCH
1	EA	CLOSER	4040XP	689	LCN
1	EA	OVERHEAD STOP	100H	630	GLY

SET 04

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	STOREROOM LOCK	ND80 x RHO	626	SCH
1	EA	CLOSER	4040XP	689	LCN
1	EA	WALL STOP	WS407	630	IVE
1	EA	ELECTRIC STRIKE	6211	630	VON
1	EA	CARD READER	BY SECURITY CONTRACTOR		

SET 05

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	STOREROOM LOCK	ND80 x RHO	626	SCH
1	EA	CLOSER	4040XP H	689	LCN
1	EA	WALL STOP	WS407	630	IVE

SET 06

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	STOREROOM LOCK	ND80 x RHO	626	SCH
1	EA	CLOSER	4040XP	689	LCN
1	EA	WALL STOP	WS407	630	IVE

SET 07

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	STOREROOM LOCK	ND80 x RHO	626	SCH
1	EA	CLOSER	4040XP	689	LCN
1	EA	OVERHEAD STOP	100S	630	GLY

SET 08

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	STOREROOM LOCK	ND80 x RHO	626	SCH
1	EA	CLOSER	4040XP S CUSH	689	LCN

SET 09

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	PASSAGE SET	ND10 x RHO	626	SCH
1	EA	WALL STOP	WS407	630	IVE

SET 10

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
2	EA	POWER TRANSFER	EPT-10	SP28	VON
1	EA	PANIC DEVICE	QEL9927L-F x LBR	626	VON
1	EA	PANIC DEVICE	QEL9927EO-F x LBR	626	VON
1	EA	CYLINDER	AS REQUIRED	626	SCH
1	EA	CLOSER	4040XP	689	LCN
1	EA	CLOSER	4040XP S CUSH	689	LCN
1	EA	WALL STOP	WS407	630	IVE
1	EA	POWER SUPPLY	PS902	GRY	VON
1	EA	CARD READER	BY SECURITY CONTRACTOR		

SET 11

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	CLASSROOM LOCK	ND70 x RHO	626	SCH
2	EA	FLUSH BOLT	FB458	626	IVE
2	EA	OVERHEAD STOP	100H	630	GLY

SET 12

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	PRIVACY w/OCC IND	L9040 x L283-712 x 06A	626	SCH

1 EA WALL STOP WS407 630 IVE

SET 13

EA HINGES AS SPECIFIED ABOVE 652 HAG
1 EA POWER TRANSFER EPT-10 SP28 VON
1 EA FAIL-SECURE LOCK ND80EU x RHO 626 SCH
2 EA CLOSER 4040XP 689 LCN
1 SET AUTO FLUSH BOLT FB31P 630 IVE
1 EA COORDINATOR COR-FL x Mtg Brkts 628 IVE
2 EA OVERHEAD STOP 100S 630 GLY
1 EA CARD READER BY SECURITY CONTRACTOR

SET 14

EA HINGES AS SPECIFIED ABOVE 652 HAG
1 EA ENTRANCE LOCK ND53 x RHO 626 SCH
1 EA CLOSER 4040XP H 689 LCN
1 EA WALL STOP WS407 630 IVE

SET 15

EA HINGES AS SPECIFIED ABOVE 652 HAG
2 EA POWER TRANSFER EPT-10 SP28 VON
1 EA PANIC DEVICE QEL9927L-F x LBR 626 VON
1 EA PANIC DEVICE QEL9927EO-F x LBR 626 VON
1 EA CYLINDER AS REQUIRED 626 SCH
2 EA CLOSER 4040XP EDA 689 LCN
2 EA WALL STOP WS407 630 IVE
1 EA POWER SUPPLY PS902 GRY VON
1 EA CARD READER BY SECURITY CONTRACTOR

SET 16

EA HINGES AS SPECIFIED ABOVE 652 HAG
2 EA POWER TRANSFER EPT-10 SP28 VON
1 EA PANIC DEVICE QEL9927L-F x LBR 626 VON
1 EA PANIC DEVICE QEL9927EO-F x LBR 626 VON
1 EA CYLINDER AS REQUIRED 626 SCH
2 EA CLOSER 4040XP S CUSH 689 LCN
1 EA POWER SUPPLY PS902 GRY VON
1 EA CARD READER BY SECURITY CONTRACTOR

SET 17

EA HINGES AS SPECIFIED ABOVE 652 HAG
1 EA STOREROOM LOCK ND80 x RHO 626 SCH
2 EA CLOSER 4040XP S CUSH 689 LCN
1 SET AUTO FLUSH BOLT FB31P 630 IVE
1 EA COORDINATOR COR-FL x Mtg Brkts 628 IVE

SET 18

EA HINGES AS SPECIFIED ABOVE 652 HAG
1 EA PASSAGE SET ND10 x RHO 626 SCH
1 EA CLOSER 4040XP 689 LCN
1 EA OVERHEAD STOP 100S 630 GLY

SET 19

EA HINGES AS SPECIFIED ABOVE 652 HAG
1 EA POWER TRANSFER EPT-10 SP28 VON
1 EA FAIL-SECURE LOCK ND80EU x RHO 626 SCH

2	EA	CLOSER	4040XP	689	LCN
1	SET	AUTO FLUSH BOLT	FB31P	630	IVE
1	EA	COORDINATOR	COR-FL x Mtg Brkts	628	IVE
2	EA	OVERHEAD STOP	100 H	630	GLY
1	EA	CARD READER	BY SECURITY CONTRACTOR		

SET 20

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	STOREROOM LOCK	ND80 x RHO	626	SCH
1	EA	CLOSER	4040XP	689	LCN
1	EA	OVERHEAD STOP	100	630	GLY
1	EA	ELECTRIC STRIKE	6211	630	VON
1	EA	CARD READER	BY SECURITY CONTRACTOR		

SET 21

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	ENTRANCE LOCK	ND53 x RHO	626	SCH
1	EA	OVERHEAD STOP	100 H	630	GLY

SET 22

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
1	EA	ENTRANCE LOCK	ND53 x RHO	626	SCH
1	EA	CLOSER	4040XP S H CUSH	689	LCN

SET 23

	EA	HINGES	AS SPECIFIED ABOVE	652	HAG
2	EA	POWER TRANSFER	EPT-10	SP28	VON
1	EA	PANIC DEVICE	QEL9947L-F x LBR	626	VON
1	EA	PANIC DEVICE	QEL9947EO-F x LBR	626	VON
1	EA	CYLINDER	AS REQUIRED	626	SCH
2	EA	CLOSER	4040XP S CUSH	689	LCN
1	EA	POWER SUPPLY	PS902	GRY	VON
1	EA	CARD READER	BY SECURITY CONTRACTOR		

END OF SECTION 08 71 00

<u>Door #</u>	<u>Hdwr Set</u>										
G01	--	124	--	202	01	302	03	401	01	500	14
001	01	100	23	203	04	303	04	402	01	502	02
002	20	104	01	206	01	304	01	403	01	5002A	02
003	04	105	01	208	01	305	01	404	01	504	01
004	04	106	04	209	01	308	01	405	01	505	01
005	04	108	04	210	01	310	18	406	01	510	01
007	06	109	01	212	01	311	14	407	20	514	01
008	06	110	01	213	01	312	01	410	18	515	20
010	06	113	07	214	18	313	01	411	01	516	01
011	06	113A	07	215	06	315	09	412	01	517	01
012	06	114	07	217	06	316	03	413	01	518	22
0013	20	115	07	222	05	317	06	414	03	518A	01
013A	06	117	17	225	04	318	07	415	01	520	02
013B	08	118	01	225A	04	319	01	416	01	521	22
015	06	119	09	227	01	321	01	417	01	522	01
018	09	120	01	228	01	322	01	418	01	523	01
019	10	121	04	229	01	323	03	419	01	524	01
020	11	122	11	230	19	325	01	420	01	525	01
024	01	123	16	233	01	326	01	420A	01	526	01
025	12	123A	16	234	01	327	01	420B	17	527	01
026	12	N101	17	235	01	328	01	421	01	528	01
050	13	N104	12	236	01	329	01	422	01	529	01
051	06	N105	12	237	01	330	01	423	01	530	01
C003	14	N106	12	C202	04	331	01	424	01	531	01
C004	04	N109	04	C202A	04	332	01	425	01	535	01
C005	06	N109A	04	N204	12	333	01	426	01	536	01
N010	15			N205	12	333A	14	427	01	537	01
N014	17			N206	12	336	01	428	01	539	09
						340	04	429	01	N504	12
						341	04	430	01	N505	12
						C301	04	431	14	N506	12
						C302	04	432	03		
						N304	12	433	01		
						N305	12	434	01		
						N306	12	435	09		
								436	21		
								437	01		
								438	12		
								439	12		
								440	04		
								441	04		
								441a	20		
								442	01		
								450	04		
								451	04		
								C403	04		
								C403A	04		
								N404	12		
								N405	12		
								N406	12		

SECTION 08 71 00 - DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Hardware for wood, aluminum, hollow metal, and [_____] doors.
- B Hardware for fire-rated doors.
- C Electrically operated and controlled hardware.
- D Lock cylinders for doors that hardware is specified in other sections.
- E Thresholds.
- F Weatherstripping and gasketing.

1.02 RELATED REQUIREMENTS

- A Section 06 20 00 - Finish Carpentry: Wood door frames.
- B Section 07 92 00 - Joint Sealants: Sealants for setting exterior door thresholds.
- C Section 08 06 71 - Door Hardware Schedule: Schedule of door hardware sets.
- D Section 08 11 13 - Hollow Metal Doors and Frames.
- E Section 08 14 16 - Flush Wood Doors.
- F Section 08 14 33 - Stile and Rail Wood Doors.
- G Section 08 43 13 - Aluminum-Framed Storefronts: Door hardware, except as noted in section.
- H Section 10 14 00 - Signage: Additional signage requirements.
- I Section [_____]: Power supply to electric hardware devices.
- J Section 10 26 00 - Wall and Door Protection: Door and frame protection.
- K Section 28 10 00 - Access Control: Electronic access control devices.
- L Section 28 46 00 - Fire Detection and Alarm: Electrical connection to activate door closers.

1.03 REFERENCE STANDARDS

- A ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B BHMA (CPD) - Certified Products Directory Current Edition.
- C BHMA A156.1 - Standard for Butts and Hinges 2021.
- D BHMA A156.2 - Bored and Preassembled Locks and Latches 2017.
- E BHMA A156.3 - Exit Devices 2020.
- F BHMA A156.4 - Door Controls - Closers 2019.
- G BHMA A156.5 - Cylinders and Input Devices for Locks 2020.
- H BHMA A156.6 - Standard for Architectural Door Trim 2021.
- I BHMA A156.7 - Template Hinge Dimensions 2016.
- J BHMA A156.8 - Door Controls - Overhead Stops and Holders 2021.
- K BHMA A156.12 - Interconnected Locks 2018.
- L BHMA A156.13 - Mortise Locks & Latches Series 1000 2017.
- M BHMA A156.15 - Release Devices - Closer Holder, Electromagnetic and Electromechanical 2021.
- N BHMA A156.16 - Auxiliary Hardware 2018.
- O BHMA A156.17 - Self Closing Hinges & Pivots 2019.
- P BHMA A156.18 - Materials and Finishes 2020.
- Q BHMA A156.20 - Standard for Strap and Tee Hinges, and Hasps 2021.
- R BHMA A156.21 - Thresholds 2019.
- S BHMA A156.22 - Standard for Gasketing 2021.
- T BHMA A156.23 - Electromagnetic Locks 2017.
- U BHMA A156.24 - Delayed Egress Locking Systems 2018.

- V BHMA A156.25 - Electrified Locking Devices 2018.
 - W BHMA A156.26 - Standard for Continuous Hinges 2021.
 - X BHMA A156.28 - Standard for Recommended Practices for Mechanical Keying Systems 2018.
 - Y BHMA A156.29 - American National Standard for Exit Locks, Exit Alarms, Alarms for Exit Devices 2017.
 - Z BHMA A156.30 - High Security Cylinders 2020.
 - AA BHMA A156.31 - Electric Strikes and Frame Mounted Actuators 2019.
 - BB BHMA A156.36 - Auxiliary Locks 2020.
 - CC BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames 2016.
 - DD BHMA A156.115W - Hardware Preparation in Wood Doors with Wood or Steel Frames 2006.
 - EE DHI (H&S) - Sequence and Format for the Hardware Schedule 2019.
 - FF DHI (KSN) - Keying Systems and Nomenclature 2019.
 - GG DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames 2004.
 - HH DHI WDHS.3 - Recommended Locations for Architectural Hardware for Flush Wood Doors 1993; also in WDHS-1/WDHS-5 Series, 1996.
 - II ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
 - JJ ITS (DIR) - Directory of Listed Products Current Edition.
 - KK NEMA LD 3 - High-Pressure Decorative Laminates 2005.
 - LL NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
 - MM NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2022.
 - NN NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
 - OO NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives 2022.
 - PP NFPA 252 - Standard Methods of Fire Tests of Door Assemblies 2022.
 - QQ UL (DIR) - Online Certifications Directory Current Edition.
 - RR UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies Current Edition, Including All Revisions.
 - SS UL 437 - Standard for Key Locks Current Edition, Including All Revisions.
 - TT UL 1784 - Standard for Air Leakage Tests of Door Assemblies Current Edition, Including All Revisions.
- 1.04 ADMINISTRATIVE REQUIREMENTS
- A Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
 - B Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
 - C Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; attendance is required by affected installers and the following:
 - 1. Architect.
 - 2. Installer's Architectural Hardware Consultant (AHC).
 - 3. Hardware Installer.
 - 4. Owner's Security Consultant.
 - D Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
 - E Keying Requirements Meeting:
 - 1. Schedule meeting at project site prior to Contractor occupancy.
 - 2. Attendance Required:

- a. Contractor.
 - b. Owner.
 - c. Architect.
 - d. Installer's Architectural Hardware Consultant (AHC).
 - e. Hardware Installer.
 - f. Owner's Security Consultant.
3. Agenda:
- a. Establish keying requirements.
 - b. Verify locksets and locking hardware are functionally correct for project requirements.
 - c. Verify that keying and programming complies with project requirements.
 - d. Establish keying submittal schedule and update requirements.
4. Incorporate "Keying Requirements Meeting" decisions into keying submittal upon review of door hardware keying system including, but not limited to, the following:
- a. Access control requirements.
 - b. Key control system requirements.
 - c. Schematic diagram of preliminary key system.
 - d. Flow of traffic and extent of security required.
5. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.
6. Deliver established keying requirements to manufacturers.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- C Shop Drawings - Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 2. Comply with DHI (H&S) using door numbers and hardware set numbers as indicated in construction documents.
 3. List groups and suffixes in proper sequence.
 4. Provide complete description for each door listed.
 5. Provide manufacturer name, product names, and catalog numbers; include functions, types, styles, sizes and finishes of each item.
 6. Include account of abbreviations and symbols used in schedule.
- D Shop Drawings - Electrified Door Hardware: Submit diagrams for power, signal, and control wiring for electrified door hardware that include details of interface with building safety and security systems. Provide elevations and diagrams for each electrified door opening as follows:
1. Prepared by or under supervision of Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC).
 2. Elevations: Submit front and back elevations of each door opening showing electrified devices with connections installed and an operations narrative describing how opening operates from either side at any given time.

3. Diagrams: Submit point-to-point wiring diagram that shows each device in door opening system with related colored wire connections to each device.
 - E Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
 - F Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
 1. Submit manufacturer's parts lists and templates.
 2. Bitting List: List of combinations as furnished.
 - G Keying Schedule:
 1. Submit three (3) copies of Keying Schedule in compliance with requirements established during Keying Requirements Meeting unless otherwise indicated.
 - H Manufacturer's qualification statement.
 - I Installer's qualification statement.
 - J Supplier's qualification statement.
 - K Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
 - L Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
 - M Maintenance Materials and Tools: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Lock Cylinders: Ten for each master keyed group.
 3. Tools: One set of each special wrench or tool applicable for each different or special hardware component, whether supplied by hardware component manufacturer or not.
- 1.06 QUALITY ASSURANCE
- A Standards for Fire-Rated Doors: Maintain one copy of each referenced standard on site, for use by Architect and Contractor.
 - B Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
 - C Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least three years of documented experience.
 - D Supplier Qualifications: Company with certified Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC) to assist in work of this section.
- 1.07 DELIVERY, STORAGE, AND HANDLING
- A Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.
- 1.08 WARRANTY
- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
 - B Warranty against defects in material and workmanship for period indicated, from Date of Substantial Completion.
 1. Closers: Five years, minimum.
 2. Exit Devices: Three years, minimum.
 3. Locksets and Cylinders: Three years, minimum.
 4. Other Hardware: Two years, minimum.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B Provide individual items of single type, of same model, and by same manufacturer.
- C Provide door hardware products that comply with the following requirements:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.
 - 3. Applicable provisions of NFPA 101.
 - 4. Fire-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
 - 5. Hardware on Fire-Rated Doors: Listed and classified by UL (DIR), ITS (DIR), testing firm acceptable to authorities having jurisdiction, or [_____] as suitable for application indicated.
 - 6. Hardware for Smoke and Draft Control Doors (Indicated as "S" on Drawings): Provide door hardware that complies with local codes, and requirements of assemblies tested in accordance with UL 1784.
 - a. Air Leakage Rate: Tested in accordance with UL 1784, with air leakage rate not to exceed 3.0 cfm/sf of door opening at 0.10 inch of water for both ambient and elevated temperature tests.
 - 7. Listed and certified compliant with specified standards by BHMA (CPD).
 - 8. Auxiliary Hardware: BHMA A156.16.
 - 9. Straps and Tee Hinges: BHMA A156.20.
 - 10. Hardware Preparation for Steel Doors and Steel Frames: BHMA A156.115.
 - 11. Hardware Preparation for Wood Doors with Wood or Steel Frames: BHMA A156.115W.
 - 12. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.
- D Electrically Operated and/or Controlled Hardware: Provide necessary power supplies, power transfer hinges, relays, and interfaces as required for proper operation; provide wiring between hardware and control components and to building power connection in compliance with NFPA 70.
 - 1. See Section 28 10 00 for additional access control system requirements.
- E Lock Function: Provide lock and latch function numbers and descriptions of manufacturer's series. See Door Hardware Schedule.
- F Fasteners:
 - 1. Provide fasteners of proper type, size, quantity, and finish that comply with commercially recognized standards for proposed applications.
 - a. Aluminum fasteners are not permitted.
 - b. Provide phillips flat-head screws with heads finished to match door surface hardware unless otherwise indicated.
 - 2. Provide machine screws for attachment to reinforced hollow metal and aluminum frames.
 - a. Self-drilling (Tek) type screws are not permitted.
 - 3. Provide stainless steel machine screws and lead expansion shields for concrete and masonry substrates.
 - 4. Provide wall grip inserts for hollow wall construction.
 - 5. Provide spacers or sex bolts with sleeves for through bolting of hollow metal doors and frames.
 - 6. Fire-Rated Applications: Comply with NFPA 80.

- a. Provide wood or machine screws for hinges mortised to doors or frames, strike plates to frames, and closers to doors and frames.
 - b. Provide steel through bolts for attachment of surface mounted closers, hinges, or exit devices to door panels unless proper door blocking is provided.
7. Concealed Fasteners: Do not use through or sex bolt type fasteners on door panel sides indicated as concealed fastener locations, unless otherwise indicated.

2.02 HINGES

A Manufacturers:

1. McKinney; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. Bommer Industries, Inc; [____]: www.bommer.com/#sle.
3. D&D Technologies USA, Inc; SureClose ConcealFit: www.ddtech.com/#sle.
4. Hager Companies; [____]: www.hagerco.com/#sle.
5. Pamex, Inc; [____]: www.pamexinc.com/#sle.
6. Stanley, dormakaba Group; [____]: www.stanleyhardwarefordoors.com/#sle.
7. Studco Building Systems; EZConcept RocYork Concealed Hinges : www.studcosystems.com/#sle.
8. Waterson Corp; Self-Closing Hinge, Model [____]: www.watersonusa.com/#sle.
9. Substitutions: See Section 01 60 00 - Product Requirements.

B Hinges: Comply with BHMA A156.1, Grade 1.

1. Self Closing Hinges: Comply with BHMA A156.17.
2. Butt Hinges: Comply with BHMA A156.1 and BHMA A156.7 for templated hinges.
 - a. Provide hinge width required to clear surrounding trim.
3. Continuous Hinges: Comply with BHMA A156.26.
4. Provide hinges on every swinging door.
5. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
6. Provide ball-bearing hinges at each door with closer.
7. Provide non-removable pins on exterior outswinging doors.
8. Provide non-removable pins on interior outswinging doors at locations as indicated.
9. Provide power transfer hinges where electrified hardware is mounted in door leaf.
10. Provide following quantity of butt hinges for each door:
 - a. Doors up to 60 inches High: Two hinges.
 - b. Doors From 60 inches High up to 90 inches High: Three hinges.
 - c. Doors 90 inches High up to 120 inches High: Four hinges.
 - d. Doors over 120 inches High: One additional hinge per each additional 30 inches in height.

C Concealed Hinges: Hinges completely mortised in door and jamb such that hinge is concealed when door is closed.

1. Hinge Size: As recommended by manufacturer for door weight and size.
2. Quantity: Same as those of butt hinges for similarly sized doors.
3. Knuckles: Three.
4. Materials: Manufacturer's standard.
 - a. Body: Zinc alloy.
 - b. Base Frame: Zinc alloy.
 - c. Arms: Aluminum alloy.
 - d. Pins: Type 304 stainless steel.
 - e. Covers: ABS.

5. Products:
 - a. Sugatsune America, Inc; HES3D-E190 Concealed Door Hinge Series: www.sugatsune.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 PIVOTS

2.04 FLUSH BOLTS

- A Manufacturers:
 1. Adams Rite, an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
 2. Hager Companies; [____]: www.hagerco.com/#sle.
 3. Ives, an Allegion brand; [____]: www.allegion.com/us/#sle.
 4. Pamex, Inc; [____]: www.pamexinc.com/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B Flush Bolts: Comply with BHMA A156.16, Grade 1.
 1. Flush Bolt Throw: 3/4 inch, minimum.
 2. Provides extension bolts in leading edge of door, one bolt into floor, one bolt into top of frame.
 - a. Pairs of Swing Doors: At inactive leaves, provide flush bolts of type as required to comply with code.
 3. Provide dustproof floor strike for bolt into floor, except at metal thresholds.
 4. Manual Flush Bolts: Provide lever extensions for top bolt at over-sized doors.
 5. Self-Latching Flush Bolts: Automatically latch upon closing of door; manually retracted; located on inactive leaf of pair of doors.
 6. Automatic Flush Bolts: Automatically latch upon closing of door; automatic retraction of bolts when active leaf is opened; located on inactive leaf of pair of doors.

2.05 EXIT DEVICES

- A Manufacturers:
 1. Corbin Russwin, Sargent, or Yale; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
 2. Detex Corporation; Advantex Series [____]: www.detex.com/#sle.
 3. DORMA USA, Inc; 8000 Series: www.dorma.com/#sle.
 4. Hager Companies; [____]: www.hagerco.com/#sle.
 5. Pamex, Inc; [____]: www.pamexinc.com/#sle.
 6. Precision, dormakaba Group; [____]: www.precisionhardware.com/#sle.
 7. Stanley, dormakaba Group; [____]: www.stanleyhardwarefordoors.com/#sle.
 8. Von Duprin, an Allegion brand; [____]: www.allegion.com/us/#sle.
 9. Substitutions: See Section 01 60 00 - Product Requirements.
- B Exit Devices: Comply with BHMA A156.3, Grade 1.
 1. Lever design to match lockset trim.
 2. Provide cylinder with cylinder dogging or locking trim.
 3. Provide exit devices properly sized for door width and height.
 4. Provide strike as recommended by manufacturer for application indicated.
 5. Provide less bottom rod (LBR) at scheduled locations to eliminate use of floor mounted strikes.
 6. Provide UL (DIR) listed exit device assemblies for fire-rated doors and panic device assemblies for non-fire-rated doors.
 7. For electrical options, provide quick connect plug-in pre-wired connectors.

2.06 EXIT ALARMS

A Manufacturers:

1. Detex Corporation; Exit Alarms [____]: www.detex.com/#sle.

B Exit Alarms: Comply with BHMA A156.29.

1. Include stand-alone and exit device integrated type(s), as indicated in Door Hardware Schedule.
2. Power: 120 VAC, hardwired.
3. Standard Features: Field-selectable status indicators.
4. Arming and Disarming: By inside control key, allowing authorized entry or exit by means of an on-and-off key switch.
 - a. Key Cylinder and Keys: See Door Hardware Schedule.
5. Alarm: Manufacturer's standard piezo horn.
 - a. Loudness Rating: 100 dB.
 - b. Adjustable Allowable Bypass Time: Manufacturer's standard.
 - 1) Functionality: Factory-set and field-adjustable.
 - 2) Time Limit Settings: 5, 10, 20, and 40 minutes.
 - c. Arming Delay: 4 minutes. Designed to allow door(s) to be opened and closed repeatedly during the delay period. At the end of Arming Delay, if door(s) are open, alarm sounds. If door(s) are closed, alarm automatically arms.
 - 1) At the end of delay period, if door(s) are open, alarm sounds.
 - 2) At the end of delay period, if door(s) are closed, alarm automatically arms.
 - d. Low battery alert on applicable units.
6. Housing: Manufacturer's standard, weatherized for exterior or high-humidity environment applications.
7. Cover Plate Color: As indicated on drawings.
8. Stand-Alone Alarms: Manufacturer's standard, types required for project application.
9. Mounting: As indicated on drawings.
10. Accessories: Provide items in locations and quantities indicated.
 - a. Remote strobe units.
 - b. Warning Sign: Include with alarm.

2.07 ELECTRIC STRIKES

A Manufacturers:

1. Adams Rite, HES, or Securitron; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. Pamex, Inc; [____]: www.pamexinc.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B Electric Strikes: Comply with BHMA A156.31, Grade 1.

1. Provide UL (DIR) listed burglary-resistant electric strike; style to suit locks.
2. Provide non-handed 24 VDC electric strike suitable for door frame material and scheduled lock configuration.
3. Provide field selectable Fail Safe/Fail Secure modes.
4. Provide transformer and rectifier as necessary for complete installation.
5. Connect electric strikes into fire alarm where non-rated doors are scheduled to release with fire or sprinkler alarm condition.

2.08 ELECTROMAGNETIC LOCKS

A Manufacturers:

1. Securitron; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.

B Electromagnetic Locks: Comply with BHMA A156.23, Grade 1.

1. Holding Force: 600 lbs, minimum.
2. Voltage: 12 VDC, and provide power supplies by same manufacturer as locks.
3. Provide electromagnetic locks for fire-rated doors in compliance with UL 10C.
4. Mounting: Surface mounted to door and frame on secure side, with fasteners, brackets, and spacer bars as required for application.
5. Provide concealed sensing device within device that monitors magnetic holding force to ensure appropriate door lock.
6. Provide concealed adjustable time delay option to re-lock door, adjustable from 1 to 90 seconds.

2.09 DELAYED-EGRESS ELECTROMAGNETIC LOCKS

A Delayed-Egress Electromagnetic Locks: Comply with BHMA A156.24, Grade 1.

1. Delayed-Egress Timer: Upon depressing push bar provide 15 seconds delay before door egress permitted, in compliance with NFPA 101.
2. Holding Force: 600 lbs, minimum.
3. Voltage: 12 VDC, and provide power supplies by same manufacturer as locks.
4. Provide electromagnetic locks for fire-rated doors in compliance with UL 10C.
5. Mounting: Surface mounted to door and frame on secure side, with fasteners, brackets, and spacer bars as required for application.
6. Provide concealed sensing device that monitors magnetic holding force to ensure appropriate door lock.

2.10 LOCK CYLINDERS

A Manufacturers:

1. Best, dormakaba Group; [____]: www.bestaccess.com/#sle.
2. Substitutions: See Section 01 60 00 - Product Requirements.

B Lock Cylinders: Provide key access on outside of each lock, unless otherwise indicated.

1. Provide standard, electronic, conventional, full size interchangeable core (FSIC), and small format interchangeable core (SFIC) type cylinders, Grade 1, with six-pin core in compliance with BHMA A156.5 at locations indicated.
2. Provide high security mechanical type cylinders, Grade 1, with six-pin core in compliance with BHMA A156.30 or UL 437 at locations indicated.
3. Provide cylinders from same manufacturer as locking device.
4. Provide cams and/or tailpieces as required for locking devices.
5. Within specific Door Sections, when provisions for lock cylinder are being referenced to this Section, provide specified lock cylinder and keyed to building keying system, unless otherwise indicated.

2.11 CYLINDRICAL LOCKS

A Manufacturers:

1. Corbin Russwin, Sargent, or Yale; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. Best, dormakaba Group; [____]: www.bestaccess.com/#sle.
3. DORMA USA, Inc; C300 Series, C500 Series, C800 Series, CL700 Series, and CK700 Series: www.dorma.com/#sle.

4. Hager Companies; [____]: www.hagerco.com/#sle.
5. Pamex, Inc; [____]: www.pamexinc.com/#sle.
6. Schlage, an Allegion brand; [____]: www.allegion.com/us/#sle.
7. Stanley, dormakaba Group; [____]: www.stanleyhardwarefordoors.com/#sle.
8. Substitutions: See Section 01 60 00 - Product Requirements.

B Cylindrical Locks (Bored): Comply with BHMA A156.2, Grade 1, 4000 Series.

1. Bored Hole: 2-1/8 inch diameter.
2. Latchbolt Throw: 1/2 inch, minimum.
3. Backset: 2-3/4 inch unless otherwise indicated.
4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Finish: To match lock or latch.
 - b. Flat-Lip Strikes: Provide for locks with three piece antifriction latchbolts as recommended by manufacturer.
 - c. Aluminum-Frame Strike Box: Provide strike box fabricated for use with aluminum framing by framing manufacturer.
5. Provide a lock for each door, unless otherwise indicated that lock is not required.
6. Provide an office lockset for swinging door where hardware set is not indicated.
7. Trim: Provide lever handle or pull trim on outside of each lock, unless otherwise indicated.

2.12 MORTISE LOCKS

A Manufacturers:

1. Corbin Russwin, Sargent, or Yale; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. Best, dormakaba Group; [____]: www.bestaccess.com/#sle.
3. DORMA USA, Inc; M9000 Series: www.dorma.com/#sle.
4. Hager Companies; [____]: www.hagerco.com/#sle.
5. Stanley, dormakaba Group; [____]: www.stanleyhardwarefordoors.com/#sle.
6. Substitutions: See Section 01 60 00 - Product Requirements.

B Mortise Locks: Comply with BHMA A156.13, Grade 1, Security, 1000 Series.

1. Latchbolt Throw: 3/4 inch, minimum.
2. Deadbolt Throw: 1 inch, minimum.
3. Backset: 2-3/4 inch unless otherwise indicated.
4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Flat-Lip Strikes: Provide for locks with three piece antifriction latchbolts as recommended by manufacturer.
 - b. Aluminum-Frame Strike Box: Provide strike box fabricated for use with aluminum framing by framing manufacturer.
 - c. Finish: To match lock or latch.

2.13 ELECTROMECHANICAL LOCKS

A Manufacturers:

1. Sargent or Yale; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. Best, dormakaba Group; [____]: www.bestaccess.com/#sle.
3. Hager Companies; [____]: www.hagerco.com/#sle.

4. Schlage, an Allegion brand; [____]: www.allegion.com/us/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B Electromechanical Locks: Comply with BHMA A156.25, Grade 1.
1. Provide motor-driven or solenoid-driven locks, with strike that is applicable to frame.
 2. Type: Mortise deadbolt.
- 2.14 INTERCONNECTED LOCKS
- A Manufacturers:
1. DORMA USA, Inc; J300 Series: www.dorma.com/#sle.
 2. Hager Companies; [____]: www.hagerco.com/#sle.
 3. Pamex, Inc; [____]: www.pamexinc.com/#sle.
 4. Schlage, an Allegion brand; [____]: www.allegion.com/us/#sle.
 5. Stanley, dormakaba Group; [____]: www.stanleyhardwarefordoors.com/#sle.
 6. Substitutions: See Section 01 60 00 - Product Requirements.
- B Interconnected Locks: Comply with BHMA A156.12, Grade 1, 5000 Series.
- 2.15 AUXILIARY LOCKS (DEADLOCKS)
- A Manufacturers:
1. Yale; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
 2. Best, dormakaba Group; [____]: www.bestaccess.com/#sle.
 3. DORMA USA, Inc; D800 Series, DB600 Series, and [____]: www.dorma.com/#sle.
 4. Hager Companies; [____]: www.hagerco.com/#sle.
 5. Pamex, Inc; [____]: www.pamexinc.com/#sle.
 6. Stanley, dormakaba Group; [____]: www.stanleyhardwarefordoors.com/#sle.
 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B Auxiliary Locks (Deadlocks): Comply with BHMA A156.36, Grade 1.
1. Type: Bored (cylindrical).
 2. Application: Bored.
 3. Backset: 2-3/4 inch, unless otherwise indicated.
 4. Bolt Throw: 1/2 inch, with latch made of hardened steel.
 5. Provide strike that matches frame.
- 2.16 DOOR PULLS AND PUSH PLATES
- A Manufacturers:
1. Rockwood; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
 2. Forms+Surfaces; [____]: www.forms-surfaces.com/#sle.
 3. Hager Companies; [____]: www.hagerco.com/#sle.
 4. Hiawatha, Inc, division of Activar Construction Products Group, Inc; [____]: www.activarcpg.com/hiawatha/#sle.
 5. Pamex, Inc; [____]: www.pamexinc.com/#sle.
 6. Trimco; [____]: www.trimcohardware.com/#sle.
 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B Door Pulls and Push Plates: Comply with BHMA A156.6.
1. Pull Type: Straight, unless otherwise indicated.
 2. Push Plate Type: Flat, with square corners, unless otherwise indicated.
 - a. Edges: Beveled, unless otherwise indicated.
 3. Material: Aluminum, unless otherwise indicated.

4. Provide door pulls and push plates on doors without a lockset, latchset, exit device, or auxiliary lock unless otherwise indicated.
5. On solid doors, provide matching door pull and push plate on opposite faces.
6. On glazed storefront doors, provide matching door pulls/push plates on both faces unless otherwise indicated.

2.17 DOOR PULLS AND PUSH BARS

A Manufacturers:

1. Rockwood; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. Hager Companies; [____]: www.hagerco.com/#sle.
3. Hiawatha, Inc, division of Activar Construction Products Group, Inc; [____]: www.activarcpg.com/hiawatha/#sle.
4. Standard Metal Hardware Manufacturing Ltd; Architectural Door Pulls: www.smhardware.com/#sle.
5. Sugatsune America, Inc; Sliding Door Handles: www.sugatsune.com/#sle.
6. Trimco; [____]: www.trimcohardware.com/#sle.
7. Substitutions: See Section 01 60 00 - Product Requirements.

B Door Pulls and Push Bars: Comply with BHMA A156.6.

1. Bar Type: Bar set, unless otherwise indicated.
2. Material: Aluminum, unless otherwise indicated.

2.18 COORDINATORS

A Manufacturers:

1. Rockwood; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. DORMA USA, Inc; TS93 GSR: www.dorma.com/#sle.
3. Hiawatha, Inc, division of Activar Construction Products Group, Inc; [____]: www.activarcpg.com/hiawatha/#sle.
4. Ives, an Allegion brand; [____]: www.allegion.com/us/#sle.
5. Pamex, Inc; [____]: www.pamexinc.com/#sle.
6. Trimco; [____]: www.trimcohardware.com/#sle.
7. Substitutions: See Section 01 60 00 - Product Requirements.

B Coordinators: Provide on doors having closers and self-latching or automatic flush bolts to ensure that inactive door leaf closes before active door leaf.

1. Type: Bar, unless otherwise indicated.
2. Material: Aluminum, unless otherwise indicated.
3. Ensure that coordination of other door hardware affected by placement of coordinators and carry bar is applied properly for completely operable installation.

2.19 CARRY BAR

A Manufacturers:

1. Hiawatha, Inc, division of Activar Construction Products Group, Inc; [____]: www.activarcpg.com/hiawatha/#sle.
2. Ives, an Allegion brand; [____]: www.allegion.com/us/#sle.
3. Trimco; [____]: www.trimcohardware.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B Carry Bar: Provides a push on active door when inactive door is opened first to allow coordinator to be engaged for proper door leaf closing sequence.

1. Material: Steel with nylon rollers, unless otherwise indicated.

2.20 CLOSERS

A Manufacturers; Surface Mounted:

1. Corbin Russwin, Norton, Rixson, Sargent, or Yale; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. DORMA USA, Inc; 7400 Series, 8600 Series, 8900 Series, and TS93: www.dorma.com/#sle.
3. Hager Companies; [____]: www.hagerco.com/#sle.
4. LCN, an Allegion brand; [____]: www.allegion.com/us/#sle.
5. Pamex, Inc; [____]: www.pamexinc.com/#sle.
6. Stanley, dormakaba Group; [____]: www.stanleyhardwarefordoors.com/#sle.
7. Substitutions: See Section 01 60 00 - Product Requirements.

B Manufacturers; Concealed - Overhead:

1. DORMA USA, Inc; RTS88: www.dorma.com/#sle.
2. Substitutions: See Section 01 60 00 - Product Requirements.

C Manufacturers; Concealed - Floor Mounted:

D Manufacturers; Low Energy for ADA Applications:

1. Stanley, dormakaba Group; D-4990 Series: www.stanleyhardwarefordoors.com/#sle.
2. Substitutions: See Section 01 60 00 - Product Requirements.

E Closers: Comply with BHMA A156.4, Grade 1.

1. Type: Surface mounted to door.
2. Provide door closer on each exterior door.
3. Provide door closer on each fire-rated and smoke-rated door.
 - a. Spring hinges are not an acceptable self-closing device, unless otherwise indicated.
4. Where an overlapping astragal is included on pairs of swinging doors, provide coordinator to ensure door leaves close in proper order.
5. At corridor entry doors, mount closer on room side of door.
6. At outswinging exterior doors, mount closer on interior side of door.

2.21 OVERHEAD STOPS AND HOLDERS

A Manufacturers:

1. Rixson or Sargent; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. DORMA USA, Inc; 900 Series: www.dorma.com/#sle.
3. Glynn-Johnson, an Allegion brand; [____]: www.allegion.com/us/#sle.
4. Pamex, Inc; [____]: www.pamexinc.com/#sle.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B Overhead Stops and Holders (Door Checks): Comply with BHMA A156.8, Grade 1.

1. Provide stop for every swinging door, unless otherwise indicated.
2. Stop is not required if positive stop feature is specified for door closer; positive stop feature of door closer is not an acceptable substitute for a stop, unless otherwise indicated.

2.22 PROTECTION PLATES

A Manufacturers:

1. Rockwood; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. Hager Companies; [____]: www.hagerco.com/#sle.
3. Hiawatha, Inc, an Activar Construction Products Group company; [____]: www.activarcpg.com/hiawatha/#sle.
4. Pamex, Inc; [____]: www.pamexinc.com/#sle.

- 5. Substitutions: See Section 01 60 00 - Product Requirements.
 - B Protection Plates: Comply with BHMA A156.6.
 - C Metal Properties: Aluminum.
 - 1. Metal, Standard Duty: Thickness 0.05 inch, minimum.
 - 2. Metal, Heavy Duty: Thickness 0.062 inch, minimum.
 - 3. Metal, Extra Heavy Duty - Diamond Plate: Thickness 1/8 inch, minimum, with raised diamond plate surface.
 - 4. Metal, Extra Heavy Duty - Flat Plate: Thickness 1/8 inch, minimum, with smooth plate surface.
 - D Edges: Beveled, on four sides unless otherwise indicated.
 - E Fasteners: Countersunk screw fasteners.
 - F Provide clear anti-microbial coating that is silver ion-based.
 - G Drip Guard: Provide at head of exterior doors unless covered by roof or canopy.
- 2.23 KICK PLATES
- A Manufacturers:
 - 1. Hiawatha, Inc, an Activar Construction Products Group company;
[____]: www.activarcpg.com/hiawatha/#sle.
 - 2. Ives, an Allegion brand; [____]: www.allegion.com/us/#sle.
 - 3. Standard Metal Hardware Manufacturing Ltd; Door Plates: www.smhardware.com/#sle.
 - 4. Trimco; [____]: www.trimcohardware.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
 - B Kick Plates: Provide along bottom edge of push side of every door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.
 - 1. Size: 12 inch high by 2 inch less door width (LDW) on push side of door.
- 2.24 MOP PLATES
- A Manufacturers:
 - 1. Basis of Design: [_____].
 - 2. Hiawatha, Inc, an Activar Construction Products Group company;
[____]: www.activarcpg.com/hiawatha/#sle.
 - 3. Ives, an Allegion brand; [____]: www.allegion.com/us/#sle.
 - 4. Trimco; [____]: www.trimcohardware.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
 - B Mop Plates: Provide along bottom edge of push side of doors to provide protection from cleaning liquids and equipment damage to door surface.
 - 1. Size: 6 inch high by 1-1/2 inch less door width (LDW) on pull side and 2 inch LDW on push side of door.
- 2.25 FLOOR STOPS
- A Manufacturers:
 - 1. Rockwood; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
 - 2. Hager Companies; [____]: www.hagerco.com/#sle.
 - 3. Hiawatha, Inc, division of Activar Construction Products Group, Inc;
[____]: www.activarcpg.com/hiawatha/#sle.
 - 4. Standard Metal Hardware Manufacturing Ltd; Floor Stops: www.smhardware.com/#sle.
 - 5. Sugatsune America, Inc; Door Stoppers: www.sugatsune.com/#sle.
 - 6. Trimco; [____]: www.trimcohardware.com/#sle.

- B Floor Stops: Comply with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
 - 1. Provide floor stops when wall surface is not available; be cautious not to create a tripping hazard.
 - 2. Type: Manual hold-open, with cylindrical stop.
 - 3. Material: Aluminum housing with rubber insert.

2.26 WALL STOPS

- A Manufacturers:
 - 1. Rockwood; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
 - 2. Hager Companies; [____]: www.hagerco.com/#sle.
 - 3. Hiawatha, Inc, division of Activar Construction Products Group, Inc; [____]: www.activarcpg.com/hiawatha/#sle.
 - 4. Standard Metal Hardware Manufacturing Ltd; Wall Stops: www.smhardware.com/#sle.
 - 5. Trimco; [____]: www.trimcohardware.com/#sle.
- B Wall Stops: Comply with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
 - 1. Provide wall stops to prevent damage to wall surface upon opening door.
 - 2. Type: Bumper, concave, wall stop.
 - 3. Material: Aluminum housing with rubber insert.

2.27 ASTRAGALS

- A Manufacturers:
 - 1. Pemko; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
 - 2. Hager Companies; [____]: www.hagerco.com/#sle.
 - 3. National Guard Products, Inc; [____]: www.ngpinc.com/#sle.
 - 4. Reese Enterprises, Inc; [____]: www.reeseusa.com/#sle.
 - 5. Standard Metal Hardware Manufacturing Ltd; Astragals: www.smhardware.com/#sle.
 - 6. Zero International, Inc; [____]: www.zerointernational.com/#sle.
 - 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B Astragals: Comply with BHMA A156.22.
 - 1. Provide surface mounted astragal to cover or fill space for full door height between pair of doors or door and adjacent jamb.
 - 2. Type: Split, two parts, and with sealing gasket.
 - 3. Material: Aluminum, with neoprene weatherstripping.
 - 4. Provide non-corroding fasteners at exterior locations.

2.28 THRESHOLDS

- A Manufacturers:
 - 1. Pemko; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
 - 2. Hager Companies; [____]: www.hagerco.com/#sle.
 - 3. National Guard Products, Inc; [____]: www.ngpinc.com/#sle.
 - 4. Reese Enterprises, Inc; [____]: www.reeseusa.com/#sle.
 - 5. Zero International, Inc; [____]: www.zerointernational.com/#sle.
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.
- B Thresholds: Comply with BHMA A156.21.
 - 1. Provide threshold at each exterior door, unless otherwise indicated.
 - 2. Provide threshold with Sound Transmission Class (STC) of 25-30 at locations indicated.

3. Type: Flat surface.
4. Material: Aluminum.
5. Threshold Surface: Fluted horizontal grooves across full width.
6. Field cut threshold to profile of frame and width of door sill for tight fit.
7. Provide non-corroding fasteners at exterior locations.

2.29 WEATHERSTRIPPING AND GASKETING

A Manufacturers:

1. Pemko; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. Hager Companies; [____]: www.hagerco.com/#sle.
3. National Guard Products, Inc; [____]: www.ngpinc.com/#sle.
4. Reese Enterprises, Inc; [____]: www.reeseusa.com/#sle.

B Weatherstripping and Gasketing: Comply with BHMA A156.22.

1. Head and Jamb Type: Adjustable.
2. Door Sweep Type: Encased in retainer.
3. Material: Aluminum, with brush weatherstripping.
4. Provide gasketing for smoke and draft control doors (Indicated as "S" on Drawings) that complies with local codes, requirements of assemblies tested in accordance with UL 1784.
5. Provide frame-applied intumescent gasketing on wood doors that are labeled as smoke and draft control doors (Indicated as "S" on Drawings), unless otherwise indicated.
6. See Section 08 1416 when wood door to frame sealing system is applied by door manufacturer.
7. Provide weatherstripping on each exterior door at head, jambs, and meeting stiles of door pairs, unless otherwise indicated.
8. Provide door bottom sweep on each exterior door, unless otherwise indicated.
9. Provide sound-rated gasketing and automatic door bottom on doors indicated as "Sound-Rated", "Acoustical", or with "Sound Transmission Class (STC) rating"; fabricate as continuous gasketing, do not cut or notch gasketing material.

2.30 COAT HOOKS

A Manufacturers:

1. Basis of Design: [_____].
2. Rockwood; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B Coat Hooks: Provide on room side of door, screw fastened.

C Material: Stainless steel.

2.31 SIGNAGE

A Manufacturers:

1. Rockwood; an Assa Abloy Group company; [____]: www.assaabloydss.com/#sle.
2. [_____].
3. Substitutions: See Section 01 60 00 - Product Requirements.

B See Section 10 14 00 for additional signage requirements.

C Signage (Room Name Plates and Numbers): Provide on doors for individuals to easily identify room names and/or numbers.

1. Text Required: "RESTROOM" with symbols and braille text.
2. Material: In plastic or metal with paint used to create necessary text, adhered to door.

2.32 WIRELESS ACCESS MANAGEMENT SYSTEMS

A Manufacturers:

1. Substitutions: See Section 01 60 00 - Product Requirements.

B Wireless Access Management Systems: Comply with guidelines of BHMA A156.25, and including necessary hardware for fully functional system.

1. Reader Formats: Provide magnetic stripe, proximity, dual validation, or key Fob to activate access system functionality.
2. Door Locking Hardware: Provide applicable cylindrical locksets, panic hardware, or mortise locksets in compliance with project access control requirements.

2.33 KEY CONTROL SYSTEMS

A Manufacturers:

1. Sargent; an Assa Abloy Group company; [_____]: www.assaabloydss.com/#sle.
2. Best, dormakaba Group; [_____]: www.bestaccess.com/#sle.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B Key Control Systems: Comply with guidelines of BHMA A156.28.

1. Provide keying information in compliance with DHI (KSN) standards.
2. Keying: Grand master keyed.
3. Include construction keying and control keying with removable core cylinders.
4. Key to existing keying system.
5. Supply keys in following quantities:
 - a. 4 each Master keys.
 - b. 1 each Grand Master keys.
 - c. 1 each Great Grand Master keys.
 - d. 6 each Construction Master keys.
 - e. 15 each Construction keys.
 - f. 2 each Construction Control keys.
 - g. 2 each Control keys if new system.
 - h. 2 each Extra Cylinder cores.
 - i. 2 each Change keys for each keyed core.
6. Key Management System: For each keyed lock on project, provide one set of consecutively numbered duplicate key tags with hanging hole and snap catch.
7. Security Key Tags: For each keyed lock on project, provide one set of matching key tags for permanent attachment to one key of each set.
8. Provide key collection envelopes, receipt cards, and index cards in quantity suitable to manage number of keys.
9. Deliver keys with identifying tags to Owner by security shipment direct from hardware supplier.
10. Permanent Keys and Cores: Stamped with applicable key marking for identification. Do not include actual key cuts within visual key control marks or codes. Stamp permanent keys "Do Not Duplicate."
11. Owner or Owner's agent install permanent cores and return construction cores to hardware supplier. Construction cores and keys to remain property of hardware supplier.

2.34 POWER SUPPLY

A Manufacturers:

1. Basis of Design: [_____].
2. Detex Corporation; Series 800 Power Supply [_____]: www.detex.com/#sle.

3. Securitron; an Assa Abloy Group company; [_____]: www.assaabloydss.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B Power Supply: Hard wired, with multiple zones providing eight (8) breakers for each output panel with individual control switches and LED's; UL (DIR) Class 2 listed.
1. Power: 24 VAC, 10 Amp; with 120 VAC power supply.
 2. Operating Temperature: 32 to 110 degrees F.
 3. Provide with emergency release terminals that release devices upon activation of fire alarm system.

2.35 FINISHES

- A Finishes: Identified in Section 08 0671 - Door Hardware Schedule.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.
- B Verify that electric power is available to power operated devices and of correct characteristics.

3.02 INSTALLATION

- A Install hardware in accordance with manufacturer's instructions and applicable codes.
- B Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
- C Install hardware for smoke and draft control doors in accordance with NFPA 105.
- D Use templates provided by hardware item manufacturer.
- E Do not install surface mounted items until application of finishes to substrate are fully completed.
- F Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list; unless noted otherwise in Door Hardware Schedule or on drawings.
1. For Steel Doors and Frames: Install in compliance with DHI (LOCS) recommendations.
 2. For Steel Doors and Frames: See Section 08 11 13.
 3. For Steel Door Frames: See Section 08 12 13.
 4. For Aluminum-Framed Storefront Doors and Frames: See Section 08 43 13.
 5. For Wood Doors: Install in compliance with DHI WDHS.3 recommendations.
 6. Flush Wood Doors: See Section 08 14 16.
 7. Stile and Rail Wood Doors: See Section 08 14 33.
 8. Mounting heights in compliance with ADA Standards:
 - a. Locksets: 40-5/16 inch.
 - b. Push Plates/Pull Bars: 42 inch.
 - c. Deadlocks (Deadbolts): 48 inch.
 - d. Exit Devices: 40-5/16 inch.
 - e. Door Viewer: 43 inch; standard height 60 inch.
- G Set exterior door thresholds with full-width bead of elastomeric sealant at each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.
1. See Section 07 92 00 for additional requirements.

3.03 FIELD QUALITY CONTROL

- A Perform field inspection and testing under provisions of Section 01 40 00 - Quality Requirements.
- B Provide an Architectural Hardware Consultant (AHC) to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.04 ADJUSTING

- A Adjust work under provisions of Section 01 70 00 - Execution and Closeout Requirements.
- B Adjust hardware for smooth operation.
- C Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.05 CLEANING

- A Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.
- B Clean adjacent surfaces soiled by hardware installation.
- C Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.
- D See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.

3.06 PROTECTION

- A Protect finished Work under provisions of Section 01 70 00 - Execution and Closeout Requirements.
- B Do not permit adjacent work to damage hardware or finish.

END OF SECTION 08 71 00

SECTION 08 80 00 - GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Insulating glass units.
- B Glazing units.
- C Laminated glass interlayers.
- D Glazing compounds.

1.02 RELATED REQUIREMENTS

- A Section 08 11 13 - Hollow Metal Doors and Frames: Glazed lites in doors and borrowed lites.
- B Section 08 14 16 - Flush Wood Doors: Glazed lites in doors.
- C Section 08 43 13 - Aluminum-Framed Storefronts: Glazing provided as part of storefront assembly.
- D Section 08 88 13 - Fire-Rated Glazing.

1.03 REFERENCE STANDARDS

- A 16 CFR 1201 - Safety Standard for Architectural Glazing Materials Current Edition.
- B ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test 2015 (Reaffirmed 2020).
- C ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers 2005 (Reapproved 2019).
- D ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- E ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- F ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass 2019.
- G ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
- H ASTM C1349 - Standard Specification for Architectural Flat Glass Clad Polycarbonate 2017.
- I ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass 2021a.
- J ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings 2016.
- K ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation 2019.
- L GANA (SM) - GANA Sealant Manual 2008.
- M NFRC 100 - Procedure for Determining Fenestration Product U-factors 2020.
- N NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence 2020.
- O NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems 2020.
- P UL 752 - Standard for Bullet-Resisting Equipment Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by each of the affected installers.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data on Insulating Glass Unit and Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D Samples: Submit two samples 12 by 12 inch in size of glass units.

- E Samples: Submit 6 inch long bead of glazing sealant, color as selected.
- F Manufacturer's qualification statement.
- G Installer's qualification statement.
- H Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.
- C Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.07 MOCK-UPS

- A See Section 01 40 00 - Quality Requirements for additional requirements.
- B Provide on-site glazing mock-up with the specified glazing components.
- C Locate where directed.
- D Mock-ups may remain as part of the Work.

1.08 FIELD CONDITIONS

- A Do not install glazing when ambient temperature is less than 40 degrees F.
- B Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.09 WARRANTY

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.
- C Laminated Glass: Provide a five (5) year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Glass Fabricators:
 - 1. Viracon, Inc: www.viracon.com/#sle.
- B Float Glass Manufacturers:
 - 1. Guardian Glass, LLC; [____]: www.guardianglass.com/#sle.
 - 2. Pilkington North America Inc; [____]: www.pilkington.com/na/#sle.
 - 3. Saint Gobain North America; [____]: www.saint-gobain.com/#sle.
- C Laminated Glass Manufacturers:
 - 1. Cardinal Glass Industries; [____]: www.cardinalcorp.com/#sle.
 - 2. Thompson I.G., LLC; Laminated Glass: www.thompsonig.com/#sle.
 - 3. Viracon, Architectural Glass segment of Apogee Enterprises, Inc; [____]: www.viracon.com/#sle.

2.02 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.

2. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
3. Glass thicknesses listed are minimum.
- B Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
 1. In conjunction with weather barrier related materials described in other sections, as follows:
- C Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.03 GLASS MATERIALS

- A Float Glass: Provide float glass based glazing unless otherwise indicated.
 1. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
- B Laminated Glass: Float glass laminated in accordance with ASTM C1172.
 1. Laminated Safety Glass: Complies with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.

2.04 INSULATING GLASS UNITS

- A Manufacturers:
 1. Cardinal Glass Industries; [____]: www.cardinalcorp.com/#sle.
 2. Guardian Glass, LLC; [____]: www.guardianglass.com/#sle.
 3. Viracon, Apogee Enterprises, Inc; [____]: www.viracon.com/#sle.
- B Fabricator: Certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.
- C Insulating Glass Units: Types as indicated.
 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 3. Spacer Color: Black.
 4. Edge Seal:
 - a. Color: Black.
 5. Purge interpane space with dry air, hermetically sealed.
- D Type IG-1 - Insulating Glass Units: Vision glass, double glazed.
 1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with air.
 3. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 - b. Coating: Low-E (passive type), on #2 surface.
 4. Inboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.

5. Total Thickness: 1 inch.
 6. Thermal Transmittance (U-Value), [____]: 0.24, nominal.
 7. Visible Light Transmittance (VLT): [____] percent, nominal.
 8. Solar Heat Gain Coefficient (SHGC): 0.27, nominal.
- E Type IG-2 - Insulating Glass Units: Spandrel glazing.
1. Applications: Exterior spandrel glazing unless otherwise indicated.
 2. Space between lites filled with air.
 3. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 - b. Coating: Same as on vision units, on #2 surface.
 4. Inboard Lite: Fully tempered float glass, 1/4 inch thick.
 - a. Tint: Clear.
 - b. Opacifier: Ceramic frit, on #4 surface.
 5. Total Thickness: 1 inch.
 6. Thermal Transmittance (U-Value): 0.24, nominal.

2.05 GLAZING UNITS

- A Type GL-01 - Monolithic Interior Vision Glazing:
1. Applications: As indicated on drawings.
 2. Glass Type: Fully tempered float glass.
 3. Tint: Clear.
 4. Thickness: 1/4 inch, nominal.
- B Type GL-02 - Glass-Clad Polycarbonate Security Glazing: Laminated glass and polycarbonate, 2-Ply; ASTM C1349.
1. Applications: Locations as indicated on drawings.
 2. Tint: Clear.
 3. Thickness: As required to meet performance criteria.
 4. Outer Lite: Tempered glass.
 5. Interlayer: Polyvinyl butyral (PVB), thickness as required to meet performance criteria.
 6. Inside Lite: Polycarbonate.
 7. Performance Criteria:
 - a. Bullet Resistance: Pass UL 752 tests in compliance with ballistic criteria level and weapon description indicated; Level 7 - 5.56 mm rifle full metal copper jacket, with lead core.
- C Type GL-03 - Fire-Rated Interior Glazing.
1. Applications: Locations as indicated on drawings. See Section 08 88 13.
 2. Configuration: As indicated on drawings in compliance with fabricators requirements.
 3. Thickness: 1/4 inch.

2.06 GLAZING COMPOUNDS

- A Type GC-5 - Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; [____] color.

2.07 ACCESSORIES

- A Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.

- B Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.

PART 3 EXECUTION

3.01 INSTALLERS

A Installer List:

1. Substitution Limitations: Same as specified for products, see Section 01 60 00 - Product Requirements.

3.02 VERIFICATION OF CONDITIONS

- A Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.

3.03 INSTALLATION, GENERAL

- A Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.
- B Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.

3.04 INSTALLATION - DRY GLAZING METHOD (TAPE AND TAPE)

- A Application - Interior Glazed: Set glazing infills from the interior of the building.
- B Cut glazing tape to length and set against permanent stops, projecting 1/16 inch above sight line.
- C Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- D Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
- E Place glazing tape on free perimeter of glazing in same manner described above.
- F Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
- G Carefully trim protruding tape with knife.

3.05 INSTALLATION - WET/DRY GLAZING METHOD (TAPE AND SEALANT)

- A Application - Interior Glazed: Set glazing infills from the interior of the building.
- B Cut glazing tape to length and install against permanent stops, projecting 1/16 inch above sight line.
- C Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- D Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.
- E Install removable stops, spacer shims inserted between glazing and applied stops at 24 inch intervals, 1/4 inch below sight line.
- F Fill gaps between pane and applied stop with [] type sealant to depth equal to bite on glazing, to uniform and level line.
- G Carefully trim protruding tape with knife.

END OF SECTION 08 80 00

SECTION 08 83 00 - MIRRORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Glass mirrors.
 - 1. Annealed float glass.
 - 2. Tempered safety glass.

1.02 RELATED REQUIREMENTS

- A Section 10 28 00 - Toilet, Bath, and Laundry Accessories: Metal mirror frames.

1.03 REFERENCE STANDARDS

- A ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- B ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- C ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- D ASTM C1036 - Standard Specification for Flat Glass 2021.
- E ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- F ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
- G ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror 2018.
- H GANA (GM) - GANA Glazing Manual 2008.
- I GANA (SM) - GANA Sealant Manual 2008.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data on Mirror Types: Submit structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C Product Data on Glazing Compounds: Submit chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D Manufacturer's Certificate: Certify that mirrors, meets or exceeds specified requirements.
- E Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- F Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

- A Fabricate, store, transport, receive, install, and clean mirrors in accordance with manufacturer's recommendations.

1.06 FIELD CONDITIONS

- A Do not install mirrors when ambient temperature is less than 50 degrees F.
- B Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.07 WARRANTY

- A See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B Provide five year manufacturer warranty for reflective coating on mirrors and replacement of same.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Mirrors:

2.02 MATERIALS

END OF SECTION 08 83 00

SECTION 08 88 13 - FIRE-RATED GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

A Fire-rated glazing units.

1.02 RELATED REQUIREMENTS

A Section 08 11 13 - Hollow Metal Doors and Frames: Glazed lites in doors, borrowed lites, and transoms.

B Section 08 43 13 - Aluminum-Framed Storefronts: Glazing furnished as part of storefront assembly.

1.03 REFERENCE STANDARDS

A 16 CFR 1201 - Safety Standard for Architectural Glazing Materials Current Edition.

B ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.

C ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.

D ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.

E GANA (SM) - GANA Sealant Manual 2008.

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

G ITS (DIR) - Directory of Listed Products Current Edition.

H NFPA 252 - Standard Methods of Fire Tests of Door Assemblies 2022.

I NFPA 257 - Standard on Fire Test for Window and Glass Block Assemblies 2022.

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

K UL 9 - Standard for Fire Tests of Window Assemblies Current Edition, Including All Revisions.

L UL 10B - Standard for Fire Tests of Door Assemblies Current Edition, Including All Revisions.

M UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies Current Edition, Including All Revisions.

1.04 SUBMITTALS

A See Section 01 30 00 - Administrative Requirements for submittal procedures.

B Product Data on Glazing Unit Glazing Types: Provide structural, physical, and environmental characteristics, size limitations, special handling and installation requirements.

C Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.

1.05 QUALITY ASSURANCE

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

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

1.06 FIELD CONDITIONS

A Ambient Conditions: Do not install glazing when ambient temperature is less than 40 degrees F.

B Maintain minimum ambient temperature before, during, and 24 hours after installation of glazing compounds.

1.07 WARRANTY

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A Glass Fabricators:

1. Trulite Glass & Aluminum Solutions, LLC; [_____]: www.trulite.com/#sle.

2. Viracon, Inc; [____]: www.viracon.com/#sle.

B Fire-Protection-Rated Glass:

1. Manufacturers:

- a. SCHOTT North America Inc; PYRAN Platinum: www.us.schott.com/#sle.
- b. Technical Glass Products; [____]: www.fireglass.com/#sle.

2.02 GLASS MATERIALS

A Float Glass: Provide float glass based glazing unless otherwise indicated.

1. Kind FT - Fully Tempered Type: Comply with ASTM C1048.

2.03 GLAZING UNITS

A Type GL-03 - Fire-Protection-Rated Glazing: Type, thickness, and configuration of glazing that contains flame, smoke, and does not block radiant heat, as required to achieve indicated fire rating period as indicated on drawings.

1. Applications:

- a. Glazing in fire-resistance-rated door assembly.
 - b. Other locations as indicated on drawings.
2. Provide products listed by ITS (DIR) or UL (DIR) and approved by authorities having jurisdiction.
 3. Safety Glazing Certification: 16 CFR 1201 Category II.
 4. Fire-Rating Period: As indicated on drawings.
 5. Markings for Fire-Protection-Rated Glazing Assemblies: Provide permanent markings on fire-protection-rated glazing in compliance with ICC (IBC), local building code, and authorities having jurisdiction
 - a. "D" - meets fire door assembly criteria of NFPA 252, UL 10B, or UL 10C fire test standards.
 - b. "OH" - meets fire window assembly criteria, including hose stream test of NFPA 257 or UL 9 fire test standards.
 - c. "H" - meets fire door assembly hose stream test of NFPA 252, UL 10B, or UL 10C fire tests standards.
 - d. "XXX" - placeholder that represents fire-rating period, in minutes.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers unless more stringent requirements are indicated, including those in referenced glazing standards.
- B Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- E Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- F Prevent glass from contact with contaminating substances that may result from construction operations including, but not limited to weld spatter, fire-safing, plastering, mortar droppings, etc.

END OF SECTION 08 88 13

SECTION 09 05 61 - COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
 - 1. Carpet tile.
 - 2. Thin-set ceramic tile and stone tile.
- B Removal of existing floor coverings.
- C Preparation of new and existing concrete floor slabs for installation of floor coverings.
- D Testing of concrete floor slabs for moisture and alkalinity (pH).
- E Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
 - 1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.
- F Patching compound.
- G Remedial floor coatings.
- H Remedial floor treatment.
- I Remedial floor sheet membrane.

1.02 RELATED REQUIREMENTS

- A Section 01 22 00 - Unit Prices: Bid pricing for remediation treatments if required.
- B Section 01 23 00 - Alternates: Bid pricing for remediation treatments if required.
- C Section 01 40 00 - Quality Requirements: Additional requirements relating to testing agencies and testing.
- D Section 01 74 19 - Construction Waste Management and Disposal: Handling of existing floor coverings removed.
- E Section 03 30 00 - Cast-in-Place Concrete: Moisture emission reducing curing and sealing compound for slabs to receive adhered flooring, to prevent moisture content-related flooring failures; to remain in place, not to be removed.
- F Section 03 54 00 - Cast Underlayment: Self-leveling underlayment applied as remediation treatment.

1.03 REFERENCE STANDARDS

- A ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens) 2021.
- B ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete 2020.
- C ASTM D4259 - Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application 2018.
- D ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring 2021.
- E ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride 2022.
- F ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes 2019a.
- G RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings 2011.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Visual Observation Report: For existing floor coverings to be removed.
- C Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
 - 1. Moisture and alkalinity (pH) limits and test methods.
 - 2. Manufacturer's required bond/compatibility test procedure.
- D Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.
 - 1. Manufacturer's qualification statement.
 - 2. Certificate: Manufacturer's certification of compatibility with types of flooring applied over remedial product.
 - 3. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.
 - 4. Manufacturer's installation instructions.
- E Testing Agency's Report:
 - 1. Description of areas tested; include floor plans and photographs if helpful.
 - 2. Summary of conditions encountered.
 - 3. Moisture and alkalinity (pH) test reports.
 - 4. Copies of specified test methods.
 - 5. Recommendations for remediation of unsatisfactory surfaces.
 - 6. Submit report to Architect.
 - 7. Submit report not more than two business days after conclusion of testing.
- F Adhesive Bond and Compatibility Test Report.
- G Floor Moisture Testing Technician Certificate: International Concrete Repair Institute (ICRI) Concrete Slab Moisture Testing Technician- Grade I certificate.
- H Copy of RFCI (RWP).

1.06 QUALITY ASSURANCE

- A Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.
- B Contractor may perform adhesive and bond test with Contractor's own personnel or hire a testing agency.
- C Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
 - 1. Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.
 - 2. Acceptable Testing Agencies:
 - a. Independent Floor Testing & Inspection, Inc. (IFTI): www.ifti.com/#sle.
 - b. Substitutions: Not permitted.
- D Contractor's Responsibility Relating to Independent Agency Testing:
 - 1. Provide access for and cooperate with testing agency.
 - 2. Confirm date of start of testing at least 10 days prior to actual start.
 - 3. Allow at least 4 business days on site for testing agency activities.

4. Achieve and maintain specified ambient conditions.
 5. Notify Architect when specified ambient conditions have been achieved and when testing will start.
- E Floor Moisture Testing Technician Qualifications: International Concrete Repair Institute (ICRI) Concrete Slab Moisture Testing Technician Certification- Grade I.
- F Remedial Coating Installer Qualifications: Company specializing in performing work of the type specified in this section, trained by or employed by coating manufacturer, and able to provide at least 3 project references showing at least 3 years' experience installing moisture emission coatings.
- 1.07 DELIVERY, STORAGE, AND HANDLING
- A Deliver, store, handle, and protect products in accordance with manufacturer's instructions and recommendations.
 - B Deliver materials in manufacturer's packaging; include installation instructions.
 - C Keep materials from freezing.
- 1.08 FIELD CONDITIONS
- A Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.
 - B Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 PRODUCTS

2.01 MATERIALS

- A Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
 2. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.
 3. Products:
 - a. ARDEX Engineered Cements; ARDEX Feather Finish: www.ardexamericas.com/#sle.
 - b. Floor Seal Technology, Inc; Color Match Patch: www.floorseal.com/#sle.
 - c. H.B. Fuller Construction Products, Inc; TEC Feather Edge Skim Coat: www.tecspecialty.com/#sle.
 - d. USG Corporation; Durock Brand Advanced Skim Coat Floor Patch: www.usg.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- B Alternate Flooring Adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and pH conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by adhesive manufacturer as suitable for substrate and floor covering and for conditions present.
- C Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
1. Thickness: As required for application and in accordance with manufacturer's installation instructions.
 2. Products:

- a. ARDEX Engineered Cements; ARDEX MC RAPID: www.ardexamericas.com/#sle.
 - b. LATICRETE International, Inc; LATICRETE NXT Vapor Reduction Coating with LATICRETE NXT Level Plus: www.laticrete.com/#sle.
 - c. LATICRETE International, Inc; LATICRETE SUPERCAP Moisture Vapor Control with LATICRETE SUPERCAP Underlayment: www.laticrete.com/#sle.
 - d. Stauf USA, LLC; ERP-270 Perma-Seal: www.staufusa.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- D Remedial Floor Treatment: Penetrating, spray-applied, silicate-based product intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
1. Products:
 - a. AVECS, LLC; RE-ACT: www.avecs.build/#sle.
- E Remedial Floor Sheet Membrane: Pre-formed multi-ply sheet membrane installed over concrete subfloor and intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
1. Thickness: 28 mil (0.028 inch).
 2. Tape: Types recommended by underlayment manufacturer to install membrane and cover seams.
 3. Products:
 - a. GCP Applied Technologies; Kovara MBX: www.gcpat.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 CONCRETE SLAB PREPARATION

- A Perform following operations in the order indicated:
1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:
 - a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
 - b. Removal of existing floor covering.
 2. Preliminary cleaning.
 3. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
 4. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
 5. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
 6. Specified remediation, if required.
 7. Patching, smoothing, and leveling, as required.
 8. Other preparation specified.
 9. Adhesive bond and compatibility test.
 10. Protection.
- B Remediations:
1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.

2. Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating or remedial sheet membrane over entire suspect floor area.
 3. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.
- 3.02 REMOVAL OF EXISTING FLOOR COVERINGS
- A Comply with local, State, and federal regulations and recommendations of RFCI (RWP), as applicable to floor covering being removed.
 - B Dispose of removed materials in accordance with local, State, and federal regulations and as specified.
- 3.03 PRELIMINARY CLEANING
- A Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.
 - B Do not use solvents or other chemicals for cleaning.
- 3.04 MOISTURE VAPOR EMISSION TESTING
- A Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
 - B Where this specification conflicts with the referenced test method, comply with the requirements of this section.
 - C Test in accordance with ASTM F1869 and as follows.
 - D Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.
 - E In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.
 - F Report: Report the information required by the test method.
- 3.05 INTERNAL RELATIVE HUMIDITY TESTING
- A Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
 - B Where this specification conflicts with the referenced test method, comply with the requirements of this section.
 - C Test in accordance with ASTM F2170 Procedure A and as follows.
 - D Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.
 - E In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.
 - F Report: Report the information required by the test method.

3.06 ALKALINITY TESTING

- A Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B The following procedure is the equivalent of that described in ASTM F710, repeated here for the Contractor's convenience.
 - 1. Use a wide range alkalinity (pH) test paper, its associated chart, and distilled or deionized water.
 - 2. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity (pH) test paper into the water, remove it, and compare immediately to chart to determine alkalinity (pH) reading.
 - 3. Use of a digital pH meter with probe is acceptable; follow meter manufacturer's instructions.
- C In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

3.07 PREPARATION

- A See individual floor covering section(s) for additional requirements.
- B Comply with recommendations of testing agency.
- C Comply with requirements and recommendations of floor covering manufacturer.
- D Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.
- E Do not fill expansion joints, isolation joints, or other moving joints.

3.08 ADHESIVE BOND AND COMPATIBILITY TESTING

- A Comply with requirements and recommendations of floor covering manufacturer.

3.09 APPLICATION OF REMEDIAL FLOOR COATING

- A Comply with requirements and recommendations of coating manufacturer.

3.10 APPLICATION OF REMEDIAL FLOOR TREATMENT

- A Comply with requirements and recommendations of treatment manufacturer.

3.11 INSTALLATION OF REMEDIAL FLOOR SHEET MEMBRANE

- A Install in accordance with sheet membrane manufacturer's instructions.

3.12 PROTECTION

- A Cover prepared floors with building paper or other durable covering.

END OF SECTION 09 05 61

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Performance criteria for gypsum board assemblies.
- B Metal stud wall framing.
- C Metal channel ceiling framing.
- D Resilient sound isolation clips.
- E Acoustic insulation.
- F Gypsum sheathing.
- G Cementitious backing board.
- H Gypsum wallboard.
- I Joint treatment and accessories.
- J Acoustic (sound-dampening) wall and ceiling board.
- K Bullet resistant sheathing and wallboard.

1.02 RELATED REQUIREMENTS

- A Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B Section 05 40 00 - Cold-Formed Metal Framing: Structural steel stud framing.
- C Section 06 10 00 - Rough Carpentry: Building framing and sheathing.
- D Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.
- E Section 07 21 00 - Thermal Insulation: Acoustic insulation.
- F Section 07 25 00 - Weather Barriers: Water-resistive barrier over sheathing.
- G Section 07 84 00 - Firestopping: Top-of-wall assemblies at fire-resistance-rated walls.
- H Section 07 92 00 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.
- I Section 09 22 16 - Non-Structural Metal Framing.
- J Section 09 30 00 - Tiling: Tile backing board.
- K Section 31 31 16 - Termite Control: Field-applied termiticide and mildewcide for metal framing.

1.03 REFERENCE STANDARDS

- A AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members 2016, with Supplement (2020).
- B ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units 2018.
- C ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units 2019.
- D ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- F ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- G ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process 2022.
- H ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members 2015.

- I ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- J ASTM C208 - Standard Specification for Cellulosic Fiber Insulating Board 2022.
- K ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method 2022.
- L ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board 2017 (Reapproved 2022).
- M ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board 2004 (Reapproved 2020).
- N ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing 2003 (Reapproved 2017).
- O ASTM C645 - Standard Specification for Nonstructural Steel Framing Members 2018.
- P ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing 2017.
- Q ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products 2020.
- R ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board 2020.
- S ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness 2022.
- T ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs 2022.
- U ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base 2019.
- V ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing 2017.
- W ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel 2018.
- X ASTM C1278/C1278M - Standard Specification for Fiber-Reinforced Gypsum Panel 2017.
- Y ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing 2018.
- Z ASTM C1288 - Standard Specification for Fiber-Cement Interior Substrate Sheets 2017.
- AA ASTM C1325 - Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units 2022.
- BB ASTM C1396/C1396M - Standard Specification for Gypsum Board 2017.
- CC ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels 2019.
- DD ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels 2019, with Editorial Revision (2020).
- EE ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2021.
- FF ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- GG ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).
- HH ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.
- II ASTM E413 - Classification for Rating Sound Insulation 2022.

- JJ ASTM E1264 - Standard Classification for Acoustical Ceiling Products 2022.
- KK ASTM E1414/E1414M - Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum 2021a.
- LL ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems 2015 (Reapproved 2019).
- MM ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).
- NN GA-216 - Application and Finishing of Gypsum Panel Products 2021.
- OO GA-600 - Fire Resistance and Sound Control Design Manual 2021.
- PP ICC (IBC) - International Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- QQ ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers 2016, with Editorial Revision (2019).
- RR ISO 16000-23 - Indoor Air – Part 23: Performance Test for Evaluating the Reduction of Formaldehyde and Other Carbonyl Compounds Concentrations by Sorptive Building Materials 2018.
- SS SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2021.
- TT UL (FRD) - Fire Resistance Directory Current Edition.
- UU UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances Current Edition, Including All Revisions.
- VV UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems Current Edition, Including All Revisions.
- WW UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.
- XX UL 752 - Standard for Bullet-Resisting Equipment Current Edition, Including All Revisions.
- YY UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.
- C Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- D Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- E Test Reports: For stud framing products that do not comply with ASTM C645 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.
- F Test Reports: Bullet resistant sheathing and wallboard.
- G SSFSA Manufacturer Qualification: Submit documentation of manufacturer association membership.
- H SSMA Manufacturer Qualification: Submit documentation of manufacturer association membership.
- I Installer's Qualification Statement.

1.05 QUALITY ASSURANCE

- A Installer Qualifications: Company specializing in performing gypsum board installation and finishing, with minimum [] years of experience.
- B Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.
- C Manufacturer Qualifications: Member of Supreme Steel Framing System Association (SSFSA): www.ssfsa.com/#sle.

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

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A Provide completed assemblies complying with ASTM C840 and GA-216.
 - 1. See PART 3 for finishing requirements.
- B Interior Partitions, Indicated as Sound-Rated: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
 - 1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of $L/240$.
 - 2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- D Shaft Walls at Elevator Shafts: Provide completed assemblies with the following characteristics:
 - 1. Air Pressure Within Shaft: Intermittent loads of 5 lbf/sq ft with maximum mid-span deflection of $L/240$.
 - 2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- E Fire-Resistance-Rated Assemblies: Provide completed assemblies with the following characteristics:
 - 1. Fire-Resistance-Rated Partitions: UL listed assembly No. [____]; [____] hour rating.
 - 2. Head of Fire-Resistance-Rated Partitions: UL listed assembly No. [____]; [____] hour rating.
 - 3. Fire-Resistance-Rated Ceilings and Soffits: One (1) hour fire rating.
 - 4. Fire-Resistance-Rated Structural Column Framing: UL listed assembly No. [____]; [____] hour rating.
 - 5. Fire-Resistance-Rated Structural Beam Framing: UL listed assembly No. [____]; [____] hour rating.
 - 6. Fire-Resistance-Rated Shaft Walls: UL listed assembly No. [____]; [____] hour rating.
 - 7. Fire-Resistance-Rated Area Separation Walls: UL listed assembly No. [____]; [____] hour rating.
 - 8. ICC IBC Item Numbers: Comply with applicable requirements of ICC IBC for the particular assembly.
 - 9. Gypsum Association File Numbers: Comply with requirements of GA-600 for the particular assembly.
 - 10. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.02 METAL FRAMING MATERIALS

- A Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. ClarkDietrich; [____]: www.clarkdietrich.com/#sle.
 - 2. Jaimes Industries; [____]: www.jaimesind.com/#sle.
 - 3. Marino; [____]: www.marinoware.com/#sle.
 - 4. R-stud, LLC; [____]: www.rstud.com/#sle.
 - 5. Phillips Manufacturing Co; [____]: www.phillipsmfg.com/#sle.
 - 6. SCAFCO Corporation; [____]: www.scafco.com/#sle.

7. Steel Construction Systems; [_____]: www.steelconsystems.com/#sle.
8. Supreme Steel Framing System Association; Supreme Stud: www.ssfsa.com/#sle.
- B Non-structural Steel Framing for Application of Gypsum Board: See Section 09 22 16.
- C Non-structural Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
 1. Studs: C-shaped with knurled or embossed faces.
 - a. Products:
 - 1) MBA Building Supplies; ProSTUD: www.mbastuds.com/#sle.
 - 2) Super Stud Building Products, Inc; The EDGE: www.buysuperstud.com/#sle.
 - 3) Substitutions: See Section 01 60 00 - Product Requirements.
 2. Paired Studs for Sound-Rated Assemblies: Engineered single-piece assemblies comprised of paired studs coupled by sound isolators, designed to replace conventional side-by-side, parallel, double-wall partition framing.
 - a. Widths: As indicated on drawings.
 - b. Products:
 - 1) Substitutions: See Section 01 60 00 - Product Requirements.
 3. Runners: U shaped, sized to match studs.
 4. Ceiling Channels: C-shaped.
 5. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
 - a. Products:
 - 1) MBA Building Supplies; MBA Furring Channel: www.mbastuds.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 6. Furring Members: U-shaped sections, minimum depth of 3/4 inch.
 - a. Products:
 - 1) MBA Building Supplies; MBA U-Channel: www.mbastuds.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 7. Furring Members: Zee-shaped sections, minimum depth of 1 inch.
 - a. Products:
 - 1) MBA Building Supplies; MBA Z-Furring: www.mbastuds.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 8. Resilient Furring Channels: Single or double leg configuration; 1/2 inch channel depth.
 - a. Products:
 - 1) ClarkDietrich; RC Deluxe Resilient Channel: www.clarkdietrich.com/#sle.
 - 2) Phillips Manufacturing Co; RC-2 Resilient Sound Channel: www.phillipsmfg.com/#sle.
 - 3) Substitutions: See Section 01 60 00 - Product Requirements.
 9. Resilient Sound Isolation Clips: Steel resilient clips with molded rubber isolators, attaches to framing; improves noise isolation performance of wall and floor-ceiling assemblies.
 - a. Products:
 - 1) ClarkDietrich; Sound Clip (CDSC): www.clarkdietrich.com/#sle.
 - 2) Keene Building Products; Cylent Assurance Clip: www.keenebuilding.com/#sle.
 - 3) PAC International, Inc; RSIC-1: www.pac-intl.com/#sle.
 - 4) Substitutions: See Section 01 60 00 - Product Requirements.
 10. Sill Plate Isolation Pads: Acoustical separation between sole plate and subfloor.

- a. Products:
 - 1) AcoustiGuard – WILREP LTD; Iso-Sill Rubber Isolation Pad: www.acoustiguard.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
- D Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
 - 1. Products:
 - a. Same manufacturer as other framing materials.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- E Area Separation Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with specified performance requirements.
 - 1. Products:
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
- F Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as indicated on drawings.
- G Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.
 - 1. Products:
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
- H Preformed Top Track Firestop Seal:
 - 1. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
 - 2. Products:
 - a. Hilti, Inc; Top Track Seal CFS TTS: www.us.hilti.com/#sle.
 - b. Specified Technologies Inc; SpeedFlex TTG Track Top Gasket: www.stfirestop.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- I Preformed Top of Wall Firestop Gasket:
 - 1. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
 - 2. Products:
 - a. Trim-Tex, Inc; Fire Gasket: www.trim-tex.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- J Non-structural Framing Accessories:
 - 1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 - 2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
 - a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
 - b. Height: 35-3/4 inches.
 - c. Products:
 - 1) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
 - 3. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.

- a. Products:
 - 1) ClarkDietrich; FastBridge Clip (FB33): www.clarkdietrich.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
- 4. Flexible Wood Backing: Fire-retardant-treated wood with sheet steel connectors.
 - a. Products:
 - 1) ClarkDietrich; Danback: www.clarkdietrich.com/#sle.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements.
- K Grid Suspension Systems: Steel grid system of main tees and support bars connected to structure using hanging wire.
 - 1. Products:
 - a. USG Corporation; Drywall Suspension System: www.usg.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 BOARD MATERIALS

- A Manufacturers - Gypsum-Based Board:
 - 1. American Gypsum Company; [____]: www.americangypsum.com/#sle.
 - 2. CertainTeed Corporation; [____]: www.certainteed.com/#sle.
 - 3. Georgia-Pacific Gypsum; [____]: www.gpgypsum.com/#sle.
 - 4. Gold Bond Building Products, LLC provided by National Gypsum Company; [____]: www.goldbondbuilding.com/#sle.
 - 5. PABCO Gypsum; [____]: www.pabco gypsum.com/#sle.
 - 6. USG Corporation; [____]: www.usg.com/#sle.
 - 7. Substitutions: See Section 01 60 00 - Product Requirements.
- B Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. Glass mat faced gypsum panels, as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
 - 3. Unfaced fiber-reinforced gypsum panels as defined in ASTM C1278/C1278M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
 - 4. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold resistant board is required at areas with moisture nearby but not requiring cementitious backer board.
 - 5. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 - 6. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 5/8 inch.
 - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
- C Backing Board For Wet Areas: One of the following products:
 - 1. Application: Surfaces behind tile in wet areas.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
 - a. Thickness: 1/2 inch.

- b. Products:
 - 1) Custom Building Products; [_____]: www.custombuildingproducts.com/#sle.
 - 2) PermaBASE Building Products, LLC provided by National Gypsum Company; PermaBase Cement Board: www.goldbondbuilding.com/#sle.
 - 3) USG Corporation; [_____]: www.usg.com/#sle.
 - 4) Substitutions: See Section 01 60 00 - Product Requirements.
- D Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
 - 1. Application: Vertical surfaces behind thinset tile, except in wet areas.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 - 4. Type: Regular and Type X, in locations indicated.
 - 5. Type X Thickness: 5/8 inch.
 - 6. Regular Board Thickness: 5/8 inch.
 - 7. Edges: Tapered.
 - 8. Products:
 - a. American Gypsum Company; M-Bloc: www.americangypsum.com/#sle.
 - b. American Gypsum Company; M-Bloc Type X: www.americangypsum.com/#sle.
 - c. Georgia-Pacific Gypsum; ToughRock Mold-Guard Gypsum Board: www.gpgypsum.com/#sle.
 - d. Georgia-Pacific Gypsum; DensArmor Plus: www.gpgypsum.com/#sle.
 - e. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
 - f. Substitutions: See Section 01 60 00 - Product Requirements.
- E Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Ceilings, unless otherwise indicated.
 - 2. Thickness: 5/8 inch.
 - 3. Edges: Tapered.
 - 4. Products:
 - a. CertainTeed Corporation; Interior Ceiling Drywall: www.certainteed.com/#sle.
 - b. Georgia-Pacific Gypsum; ToughRock Span 24 Ceiling Board: www.gpgypsum.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond High Strength LITE Gypsum Board: www.goldbondbuilding.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- F Acoustical Sound Dampening Wall and Ceiling Board: Two layers of heavy paper-faced, high-density gypsum board separated by a viscoelastic polymer layer and capable of achieving STC rating of 50 or more in typical stud wall assemblies as calculated in accordance with ASTM E413 and when tested in accordance with ASTM E90.
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 4. Products:
 - a. CertainTeed Corporation; SilentFX Quick Cut Gypsum Board: www.certainteed.com/#sle.

- b. CertainTeed Corporation; SilentFX Quick Cut Type X Gypsum Board: www.certainteed.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond SoundBreak XP Wall Board: www.goldbondbuilding.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- G Sound-Absorbing Gypsum Board Ceiling System: Perforated gypsum board with acoustic backer panels and spray-applied finish.
- 1. Thickness, Perforated Gypsum Board: 5/8 inch.
 - 2. Thickness, Backer Panels: 1 inch.
 - 3. Spray-Applied Finish: Acoustically transparent, acrylic-based finish coating.
 - 4. Noise Reduction Coefficient (NRC): Not less than 0.80 when measured and calculated in accordance with ASTM C423.
 - 5. Ceiling Attenuation Class (CAC): Not less than 44 when tested in accordance with ASTM E1414/E1414M and classified in accordance with ASTM E413.
 - 6. Products:
 - a. USG Corporation; Ensemble Acoustical Drywall Ceiling System: www.usg.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- H Bullet Resistant Sheathing and Wallboard: Woven roving, multi-ply, ballistic grade fiberglass cloth with thermoset polyester resin; comply with UL 752 Level 7.
- 1. Thickness: 1-1/8 inch.
 - 2. In 1-Hour Fire-Resistance-Rated Partitions: UL listed for assembly used.
 - 3. Products:
 - a. ArmorCore by Waco Composites; Bullet Resistant Fiberglass Panels: www.armorcore.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- I Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
- 1. Paper-Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C1396/C1396M; water-resistant faces.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Paper-Faced Products:
 - a. American Gypsum Company; M-Bloc Shaft Liner: www.americangypsum.com/#sle.
 - b. CertainTeed Corporation; M2Tech Type X Shaftliner: www.certainteed.com/#sle.
 - c. Georgia-Pacific Gypsum; ToughRock Shaftliner: www.gpgypsum.com/#sle.
 - d. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond Shaftliner XP: www.goldbondbuilding.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- 2.04 GYPSUM BOARD ACCESSORIES
- A Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness as required for STC.
- B Sound Isolation Tape: Elastomeric foam tape for sound decoupling.
- 1. Surface Burning Characteristics: Provide assemblies with flame spread index of 75 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 2. Tape Thickness: 1/4 inch.
 - 3. Products:

- a. Armacell LLC; ArmaComfort MTD: www.armacell.us/#sle.
- b. Substitutions: See Section 01 60 00 - Product Requirements.
- C Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
 - 1. Products:
 - a. Franklin International, Inc; Titebond GREENchoice Professional Acoustical Smoke and Sound Sealant: www.titebond.com/#sle.
 - b. Liquid Nails, a brand of PPG Architectural Coatings; [____]: www.liquidnails.com/#sle.
 - c. Specified Technologies Inc; Smoke N Sound Acoustical Sealant: www.stifirestop.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- D Water-Resistive Barrier: See Section 07 25 00.
- E Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
 - 1. Types: As detailed or required for finished appearance.
 - 2. Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed panel edges.
 - 3. Products:
 - a. Phillips Manufacturing Co; [____]: www.phillipsmfg.com/#sle.
 - b. Stockton Products; Extruded Aluminum: www.stocktonproducts.com/#sle.
 - c. Trim-tex, Inc; [____]: www.trim-tex.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- F Beads, Joint Accessories, and Other Trim: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
 - 1. Corner Beads: Low profile, for 90 degree outside corners.
 - a. Products:
 - 1) CertainTeed Corporation; No-Coat Drywall Corner: www.certainteed.com/#sle.
 - 2) ClarkDietrich; Strait-Flex Big-Stick: www.clarkdietrich.com/#sle.
 - 3) Phillips Manufacturing Co; Everlast Corner Bead: www.phillipsmfg.com/#sle.
 - 4) Trim-Tex, Inc; [____]: www.trim-tex.com/#sle.
 - 5) Substitutions: See Section 01 60 00 - Product Requirements.
- G Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

- A Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
 - 1. Install studs at spacing required to meet performance requirements.
- B Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.

3.03 FRAMING INSTALLATION

- A Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B Suspended Ceilings and Soffits: Space framing and furring members as indicated.
- C Studs: Space studs at 16 inches on center.

1. Extend partition framing to structure where indicated and to ceiling in other locations.
2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.

3.04 ACOUSTIC ACCESSORIES INSTALLATION

- A Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.
- C Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.05 BOARD INSTALLATION

- A Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- C Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.
- D Bullet Resistant Sheathing and Wallboard:
 1. Install bullet-resistant sheathing according to manufacturer's written recommendations and with manufacturer-approved fasteners.
 2. Cover all joints between boards with a 4 inch strip of the same thickness material as the boards, centered on the joint.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

- A Control Joints: Place control joints consistent with lines of building spaces and as indicated.
- B Corner Beads: Install at external corners, using longest practical lengths.
- C Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.07 JOINT TREATMENT

- A Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 3. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- B Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 1. Feather coats of joint compound so that camber is maximum 1/32 inch.

END OF SECTION 09 21 16

SECTION 09 30 00 - TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Tile for floor applications.
- B Tile for wall applications.
- C Tile for counters.
- D Cementitious backer board as tile substrate.
- E Coated glass mat backer board as tile substrate.
- F Ceramic trim.
- G Non-ceramic trim.

1.02 RELATED REQUIREMENTS

- A Section 07 92 00 - Joint Sealants: Sealing joints between tile work and adjacent construction and fixtures.
- B Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.
- C Section 09 21 16 - Gypsum Board Assemblies: Tile backer board.

1.03 REFERENCE STANDARDS

- A ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium) 2019.
- B ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar 2017.
- C ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar 2017.
- D ANSI A108.1c - Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar 1999 (Reaffirmed 2021).
- E ANSI A108.2 - American National Standard General Requirements: Materials, Environmental and Workmanship 2019.
- F ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesive or Water Cleanable Tile-Setting Epoxy Adhesive 2019.
- G ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar 2021.
- H ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grout Epoxy 1999 (Reaffirmed 2019).
- I ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout 1999 (Reaffirmed 2019).
- J ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout 1999 (Reaffirmed 2019).
- K ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework 2017.
- L ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units 2018.
- M ANSI A108.12 - American National Standard for Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar 1999 (Reaffirmed 2019).
- N ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone 2005 (Reaffirmed 2021).

- O ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar 2020.
 - P ANSI A108.20 - American National Standard Specifications for Exterior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs 2020.
 - Q ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive 2021.
 - R ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar 2019.
 - S ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation 2019.
 - T ANSI A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation 2019.
 - U ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units 2019.
 - V ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone 2014 (Reaffirmed 2019).
 - W ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation 2014 (Reaffirmed 2019).
 - X ANSI A136.1 - American National Standard for Organic Adhesives for Installation of Ceramic Tile 2020.
 - Y ANSI A137.1 - American National Standard Specifications for Ceramic Tile 2022.
 - Z ASTM C150/C150M - Standard Specification for Portland Cement 2022.
 - AA ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products 2018.
 - BB ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel 2018.
 - CC ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring 2021.
 - DD ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride 2022.
 - EE TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation 2021.
- 1.04 ADMINISTRATIVE REQUIREMENTS
- A Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers.
- 1.05 SUBMITTALS
- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
 - B Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
 - C Samples: Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches in size illustrating pattern, color variations, and grout joint size variations.
 - D Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Tile: 1 percent of each size, color, and surface finish combination, but not less than [_____] of each type.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.
- B Installer Qualifications:
 - 1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.

PART 2 PRODUCTS

2.01 TILE

- A Manufacturers:
 - 1. Mondani Collection: <https://mondanicollection.com/>.
 - 2. Atlas Concorde USA: <https://www.atlasconcordeusa.com/en/>
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B Glazed Wall Tile, Type [__]: ANSI A137.1 standard grade.
 - 1. Moisture Absorption: 7.0 to 20.0 percent as tested in accordance with ASTM C373.
 - 2. Size: 3" by 9" inch, nominal.
 - 3. Surface Finish: Matte glaze.
 - 4. Color(s): To be selected by Architect from manufacturer's standard range.
 - 5. Color(s): As indicated on drawings.
 - 6. Pattern: [_____].
 - 7. Trim Units: Matching bead, bullnose, cove, and base shapes in sizes coordinated with field tile.
 - 8. Products:
 - a. Mondani Collection, Boqueria: <https://mondanicollection.com/>.
 - b. [_____].
- C Porcelain Tile, Type [_____]: ANSI A137.1 standard grade.
 - 1. Moisture Absorption: 0 to 0.5 percent as tested in accordance with ASTM C373.
 - 2. Size: 6 by 6 inch, nominal.
 - 3. Thickness: 3/8 inch.
 - 4. Surface Finish: Matte glazed.
 - 5. Color(s): To be selected by Architect from manufacturer's standard range.
 - 6. Color(s): As indicated on drawings.
 - 7. Pattern: [_____].
 - 8. Trim Units: Matching bullnose, cove base, and cove shapes in sizes coordinated with field tile.
 - 9. Products:
 - a. Mondani Collection; Modern Day Terrazzo: <https://mondanicollection.com/>
 - b. Atlas Concorde USA; Fray; <https://www.atlasconcordeusa.com/en/>

2.02 TRIM AND ACCESSORIES

- A Non-Ceramic Trim: Brushed stainless steel, style and dimensions to suit application, for setting using tile mortar or adhesive.
 - 1. Applications:

- a. Open edges of wall tile: Schluter Jolly
 - b. Open edges of floor tile.
 - c. Transition between floor finishes of different heights.
 - d. Floor to wall joints; Schluter Dilex
 - e. Borders and other trim as indicated on drawings.
2. Manufacturers:
- a. Schluter-Systems: www.schluter.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 SETTING MATERIALS

- A Provide setting and grout materials from same manufacturer.
- B Manufacturers:
1. ARDEX Engineered Cements; [____]: www.ardexamericas.com/#sle.
 2. Bostik Inc; [____]: www.bostik-us.com/#sle.
 3. Custom Building Products; [____]: www.custombuildingproducts.com/#sle.
 4. H.B. Fuller Construction Products, Inc; [____]: www.tecspecialty.com/#sle.
 5. LATICRETE International, Inc; [____]: www.laticrete.com/#sle.
 6. Mapei International; www.mapei.com
 7. Substitutions: See Section 01 60 00 - Product Requirements.
- C Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.
1. Products:
 - a. ARDEX Engineered Cements; ARDEX X 5: www.ardexamericas.com/#sle.
 - b. Custom Building Products; ProLite Premium Rapid Setting Large Format Tile Mortar, with Multi-Surface Bonding Primer: www.custombuildingproducts.com/#sle.
 - c. H.B. Fuller Construction Products, Inc; TEC Ultimate Large Tile Mortar: www.tecspecialty.com/#sle.
 - d. LATICRETE International, Inc; 257 TITANIUM: www.laticrete.com/#sle.
 - e. Mapei International; Keraflex Plus; www.mapei.com
- D Organic Adhesive: ANSI A136.1, thinset mastic type.
1. Use Type I in areas subject to prolonged moisture exposure.
 2. Products:
 - a. ARDEX Engineered Cements; ARDEX D14: www.ardexamericas.com/#sle.
 - b. Custom Building Products; ReliaBond Ceramic Tile Adhesive - Type 1: www.custombuildingproducts.com/#sle.
 - c. LATICRETE International, Inc; LATICRETE 15 Premium Mastic: www.laticrete.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 GROUTS

- A Provide setting and grout materials from same manufacturer.
- B Manufacturers:
1. ARDEX Engineered Cements; [____]: www.ardexamericas.com/#sle.
 2. Bostik Inc; [____]: www.bostik-us.com/#sle.
 3. Custom Building Products; [____]: www.custombuildingproducts.com/#sle.
 4. H.B. Fuller Construction Products, Inc; [____]: www.tecspecialty.com/#sle.
 5. LATICRETE International, Inc; LATICRETE PERMACOLOR Grout: www.laticrete.com/#sle.
 6. Mapei International; Ultracolor Plus FA; www.mapei.com

- C High Performance Polymer Modified Grout: ANSI A118.7 polymer modified cement grout.
1. Applications: Use this type of grout where indicated and where no other type of grout is indicated.
 2. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
 3. Color(s): As indicated on drawings.
 4. Products:
 - a. ARDEX Engineered Cements; ARDEX FL: www.ardexamericas.com/#sle.
 - b. Custom Building Products; Prism Color Consistent Grout: www.custombuildingproducts.com/#sle.
 - c. H.B. Fuller Construction Products, Inc; TEC AccuColor Plus Grout: www.tecspecialty.com/#sle.
 - d. LATICRETE International, Inc; LATICRETE PERMACOLOR Grout: www.laticrete.com/#sle.
 - e. Mapei International; Ultracolor Plus FA; www.mapei.com
 - f. Substitutions: See Section 01 60 00 - Product Requirements.
- D Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
1. Applications: Where indicated.
 2. Color(s): As indicated on drawings.
 3. Products:
 - a. ARDEX Engineered Cements; ARDEX WA: www.ardexamericas.com/#sle.
 - b. Custom Building Products; CEG-IG 100% Solids Industrial Grade Epoxy Grout: www.custombuildingproducts.com/#sle.
 - c. H.B. Fuller Construction Products, Inc; TEC AccuColor EFX Epoxy Special Effects Grout: www.tecspecialty.com/#sle.
 - d. LATICRETE International, Inc; LATICRETE SPECTRALOCK PRO Premium Grout: www.laticrete.com/#sle.
 - e. Mapei International; Flexcolor CQ; www.mapei.com

2.05 MAINTENANCE MATERIALS

- A Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture and mildew resistant type.
1. Applications: Between tile and plumbing fixtures.
 2. Color(s): Match grout color
 3. Products:
 - a. ARDEX Engineered Cements; ARDEX SX: www.ardexamericas.com/#sle.
 - b. Custom Building Products; Commercial 100% Silicone Caulk: www.custombuildingproducts.com/#sle.
 - c. LATICRETE International, Inc; LATICRETE LATASIL: www.laticrete.com/#sle.
 - d. Mapei International; MAPESIL-T; www.mapei.com

2.06 ACCESSORY MATERIALS

- A Waterproofing Membrane at Floors: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
1. Crack Resistance: No failure at 1/16 inch gap, minimum; comply with ANSI A118.12.
 2. Fluid or Trowel Applied Type:
 - a. Material: Synthetic rubber or Acrylic.
 - b. Thickness: 25 mils, minimum, dry film thickness.

- c. Products:
 - 1) ARDEX Engineered Cements; ARDEX 8+9: www.ardexamericas.com/#sle.
 - 2) Custom Building Products; RedGard Crack Prevention and Waterproofing Membrane: www.custombuildingproducts.com/#sle.
 - 3) H.B. Fuller Construction Products, Inc; TEC HydraFlex Waterproofing Crack Isolation Membrane: www.tecspecialty.com/#sle.
 - 4) LATICRETE International, Inc; LATICRETE HYDRO BAN: www.laticrete.com/#sle.
 - 5) Merkrete, by Parex USA, Inc; Merkrete Hydro Guard 1: www.merkrete.com/#sle.
 - 6) Mapei International; AquaDefense; www.mapei.com
 - 7) Substitutions: See Section 01 60 00 - Product Requirements.
- 3. Bonded Sheet Membrane Type:
 - a. Material: Polyethylene sheet membrane with non-woven fabric laminated to both sides, 20 to 30 mils thick, nominal.
 - b. Products:
 - 1) ARDEX Engineered Cements; ARDEX SK 175: www.ardexamericas.com/#sle.
 - 2) LATICRETE International, Inc; LATICRETE HYDRO BAN Sheet Membrane: www.laticrete.com/#sle.
 - 3) Noble Company; NobleSeal TS: www.noblecompany.com/#sle.
 - 4) Substitutions: See Section 01 60 00 - Product Requirements.
 - B Backer Board: Coated glass mat type complying with ASTM C1178/C1178M; inorganic fiberglass mat on both surfaces and integral acrylic coating vapor retarder.
 - 1. Standard Type: Thickness 1/2 inch.
 - C Mesh Tape: 2 inch wide self-adhesive fiberglass mesh tape.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
- B Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- C Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A Protect surrounding work from damage.
- B Vacuum clean surfaces and damp clean.
- C Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.
- E Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

- A Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) recommendations.
- B Lay tile to pattern indicated. Do not interrupt tile pattern through openings.

- C Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E Form internal angles square and external angles bullnosed.
- F Install non-ceramic trim in accordance with manufacturer's instructions.
- G Install thresholds where indicated.
- H Sound tile after setting. Replace hollow sounding units.
- I Keep control and expansion joints free of mortar, grout, and adhesive.
- J Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- K Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- L At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

- A Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.
 - 1. Use uncoupling membrane under all tile unless other underlayment is indicated.
 - 2. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method F122, with latex-Portland cement grout.

3.05 INSTALLATION - FLOORS - MORTAR BED METHODS

- A Over interior concrete substrates, install in accordance with TCNA (HB) Method F111, with cleavage membrane, unless otherwise indicated.
 - 1. Where waterproofing membrane is indicated, with standard grout or no mention of grout type, install in accordance with TCNA (HB) Method F121.
- B Cleavage Membrane: Lap edges and ends.
- C Waterproofing Membrane: Install as recommended by manufacturer and as specified in the section in which the product is specified.
- D Mortar Bed Thickness: 5/8 inch, unless otherwise indicated.

3.06 INSTALLATION - WALL TILE

- A Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.

3.07 CLEANING

- A Clean tile and grout surfaces.

3.08 PROTECTION

- A Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION 09 30 00

SECTION 09 51 00 - ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Suspended metal grid ceiling system.
- B Acoustical units.
- C Supplementary insulation above ceiling.

1.02 RELATED REQUIREMENTS

- A Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B Section 07 21 00 - Thermal Insulation: Acoustical insulation.
- C Section 09 51 53 - Direct-Applied Acoustical Ceilings.
- D Section 09 54 21 - Metal Pan Ceilings.

1.03 REFERENCE STANDARDS

- A ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- B ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- D ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.
- E ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method 2022.
- F ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- G ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings 2022.
- H ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels 2019.
- I ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing 2017.
- J ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- K ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.
- L ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions 2022.
- M ASTM E795 - Standard Practices for Mounting Test Specimens During Sound Absorption Tests 2016.
- N ASTM E1264 - Standard Classification for Acoustical Ceiling Products 2022.
- O ASTM E1414/E1414M - Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum 2021a.
- P CHPS (HPPD) - High Performance Products Database Current Edition.
- Q ITS (DIR) - Directory of Listed Products Current Edition.
- R NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth 2019.
- S UL (FRD) - Fire Resistance Directory Current Edition.
- T UL (GGG) - GREENGUARD Gold Certified Products Current Edition.

- U UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B Do not install acoustical units until after interior wet work is dry.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Shop Drawings: Indicate grid layout and related dimensioning.
- C Product Data: Provide data on suspension system components and acoustical units.
- D Evaluation Service Reports: Show compliance with specified requirements.
- E Samples: Submit two samples ___by___ inch in size illustrating material and finish of acoustical units.
- F Samples: Submit two samples each, [____] inches long, of suspension system main runner, cross runner, and perimeter molding.
- G Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- H Manufacturer's qualification statement.
- I Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.06 QUALITY ASSURANCE

- A Designer Qualifications for Seismic Design: Perform under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the State in which the Project is located.
- B Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 FIELD CONDITIONS

- A Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Acoustic Tiles/Panels:
 - 1. Armstrong World Industries, Inc; [____]: www.armstrongceilings.com/#sle.
 - 2. USG Corporation; [____]: www.usg.com/ceilings/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B Wood Veneer Acoustic Panels:
 - 1. CertainTeed Corporation; [____]: www.certainteed.com/ceilings-and-walls/#sle.
 - 2. Armstrong World Industries, Inc; ____: www.armstrongceilings.com/#sle..
 - 3. USG Corporation; ____: www.usg.com/ceilings/#sle..
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- C Suspension Systems:
 - 1. Same as for acoustical units.

2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

A Fire-Resistance Rating: Determined in accordance with test procedures in ASTM E119 and complying with the following:

1. UL (FRD) Assembly Design No. [_____].
2. ICC-ES Evaluation Report No. [_____].

B Seismic Performance: Ceiling systems designed to withstand the effects of earthquake motions determined according to ASCE 7 for Seismic Design Category D, E, or F and complying with the following:

1. Local authorities having jurisdiction.
2. ICC-ES Evaluation Report No. [_____].

2.03 ACOUSTICAL UNITS

A Acoustical Units - General: ASTM E1264, Class A.

1. VOC Content: As specified in Section 01 61 16.

B Acoustical Panels, Type A: Painted mineral fiber, with the following characteristics:

1. Classification: ASTM E1264 Type III.
2. Size: 24 by 24 inches.
3. Thickness: 3/4 or 1 inch.
4. Light Reflectance: [_____] percent, determined in accordance with ASTM E1264.
5. NRC Range: Minimum .70, determined in accordance with ASTM E1264.
6. Ceiling Attenuation Class (CAC): Minimum 35, determined in accordance with ASTM E1264.
7. Panel Edge: Square.
8. Tile Edge: Square.
 - a. Joint: Kerfed and rabbeted.
9. Color: White.
10. Suspension System: Exposed grid.
11. Products:
 - a. Armstrong World Industries, Inc; Optima: www.armstrongceilings.com/#sle.
 - b. Armstrong World Industries, Inc; Ultima: www.armstrongceilings.com/#sle.
 - c. USG Corporation; Halcyon Eco Acoustical Panels: www.usg.com/ceilings/#sle..
 - d. USG Corporation; Mars Acoustical Panels: www.usg.com/ceilings/#sle..
 - e. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 SUSPENSION SYSTEM(S)

A Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.

1. Materials:
 - a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
 - b. Aluminum Grid: Aluminum sheet, ASTM B209/B209M.
 - c. Stainless Steel Grid: ASTM A666, Type 304.

B Exposed Suspension System, Type [_____]: Hot-dipped galvanized steel grid with steel cap.

1. Application(s): Seismic.
2. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
3. Finish: Baked enamel.
4. Color: White.

5. Products:
 - a. CertainTeed Corporation; 15/16" EZ Stab Classic System: www.certainteed.com/ceilings-and-walls/#sle.
 - b. USG Corporation; Donn Brand ZXLA 15/16 inch Acoustical Suspension System: www.usg.com/ceilings/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C Exposed Suspension System, Type [____]: Hot-dip galvanized steel grid and cap.
 1. Application(s): Seismic.
 2. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 3. Profile: Tee; 9/16 inch face width.
 4. Finish: Baked enamel.
 5. Color: White.
 6. Products:
 - a. CertainTeed Corporation; 9/16" EZ Stab Elite Narrow System: www.certainteed.com/ceilings-and-walls/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- D Exposed Suspension System, Type [____]: Hot-dip galvanized steel grid.
 1. Application(s): Seismic.
 2. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 3. Profile: Slotted Reveal Tee; 9/16 inch face width, with 1/8 inch center reveal.
 4. Finish: Baked enamel.
 5. Color: White.
 6. Products:
 - a. USG Corporation; Donn Brand Fineline 1/8 DXFF Acoustical Suspension System: www.usg.com/ceilings/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- E Exposed Suspension System, Type [____]: Hot-dip galvanized steel grid and cap.
 1. Application(s): Seismic.
 2. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 3. Profile: Double reveal Tee; 9/16 inch face width.
 4. Finish: Baked enamel.
 5. Products:
 - a. USG Corporation; Donn Brand Identitee DXI Acoustical Suspension System: www.usg.com/ceilings/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- F Exposed Suspension System, Type [____]: Hot-dip galvanized steel grid and cap.
 1. Application(s): Fire-rated assemblies.
 2. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 3. Profile: Tee; 15/16 inch face width.
 4. Finish: Baked enamel.
 5. Products:
 - a. USG Corporation; Donn Brand DX/DXL 15/16 inch Acoustical Suspension System: www.usg.com/ceilings/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 ACCESSORIES

- A Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.
- C Hold-Down Clips: Manufacturer's standard clips to suit application.
- D Seismic Clips: Manufacturer's standard clips for seismic conditions and to suit application.
- E Wood Veneer Panel Safety Clips: Galvanized 1-9/16 by 5-1/2 inch bent sheet metal clips screw anchored to back of adjacent panels and spanning over top of suspended tee grid.
 - 1. Wire Ties: No. 12 galvanized wire.
- F Wood Veneer Perimeter Trim: Field cut wood veneer panels to match acoustic ceiling panels.
 - 1. Support: Aluminum L angle, 1/8 inch thick.
- G Perimeter Moldings: Same metal and finish as grid.
 - 1. Size: As required for installation conditions and specified Seismic Design Category.
 - 2. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
 - 3. Shadow Molding: Shaped to create a perimeter reveal.
 - 4. Channel Molding: U-shaped, for hold-down type installations.
 - 5. Gaskets For Perimeter Moldings: Closed-cell foam, factory-applied to molding.
 - 6. Acoustical Sealant For Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.
- H Acoustical Insulation: Specified in Section 07 21 00.
 - 1. Thickness: 2 inch.
 - 2. Size: To fit acoustical suspension system.
- I Gypsum Board: Fire rated type; 5/8 inch thick, ends and edges square, paper faced.
- J Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify existing conditions before starting work.
- B Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

- A Install after major above-ceiling work is complete.
- B Coordinate the location of hangers with other work.
- C Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.

3.03 INSTALLATION - SUSPENSION SYSTEM

- A Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
- B Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- D Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
 - 2. Overlap and rivet corners.

- E Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F Seismic Suspension System, Seismic Design Categories D, E, F: Hang suspension system with grid ends attached to the perimeter molding on two adjacent walls; on opposite walls, maintain a 3/4 inch clearance between grid ends and wall.
- G Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- H Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- I Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- J Do not eccentrically load system or induce rotation of runners.
- K Form expansion joints as detailed. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.
- L Install light fixture boxes constructed of gypsum board above light fixtures in accordance with fire rated assembly requirements and light fixture ventilation requirements.

3.04 INSTALLATION - ACOUSTICAL UNITS

- A Install acoustical units in accordance with manufacturer's instructions.
- B Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C Fit border trim neatly against abutting surfaces.
- D Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E Cutting Acoustical Units:
 - 1. Cut to fit irregular grid and perimeter edge trim.
 - 2. Make field cut edges of same profile as factory edges.
- F Where round obstructions occur, provide preformed closures to match perimeter molding.
- G Lay acoustical insulation for a distance of 48 inches either side of acoustical partitions as indicated.
- H Install hold-down clips on each panel to retain panels tight to grid system; comply with fire rating requirements.
- I Install hold-down clips on panels within 20 ft of an exterior door.
- J Install safety clips on wood veneer panels 2 inches from outside edge of panel and at 24 inches on center.
 - 1. Use wire ties to attach safety clips.
- K Install wood veneer trim using aluminum L angle to attach to suspended grid system as required for application.

3.05 TOLERANCES

- A Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

- A See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B Replace damaged or abraded components.

END OF SECTION 09 51 00

SECTION 09 65 00 - RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Resilient sheet flooring.
- B Resilient tile flooring.
- C Static control resilient tile flooring.
- D Resilient base.
- E Resilient stair accessories.
- F Installation accessories.

1.02 RELATED REQUIREMENTS

- A Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B Section 03 30 00 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors to receive adhesive-applied resilient flooring.
- C Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.
- D Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.
- E Section 26 05 26 - Grounding and Bonding for Electrical Systems: Grounding and bonding of static control flooring to building grounding system.

1.03 REFERENCE STANDARDS

- A ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).
- B ASTM E492 - Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine 2009, with Editorial Revision (2016).
- C ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- D ASTM E2179 - Standard Test Method for Laboratory Measurement of the Effectiveness of Floor Coverings in Reducing Impact Sound Transmission Through Concrete Floors 2021.
- E ASTM F150 - Standard Test Method for Electrical Resistance of Conductive and Static Dissipative Resilient Flooring 2006 (Reapproved 2018).
- F ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring 2021.
- G ASTM F970 - Standard Test Method for Measuring Recovery Properties of Floor Coverings after Static Loading 2017.
- H ASTM F1344 - Standard Specification for Rubber Floor Tile 2021a.
- I ASTM F1861 - Standard Specification for Resilient Wall Base 2021.
- J ASTM F2169 - Standard Specification for Resilient Stair Treads 2015 (Reapproved 2020).
- K ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes 2019a.
- L NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source 2023.
- M NSF 332 - Sustainability Assessment for Resilient Floor Coverings 2015.
- N RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings 2011.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.

- B Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C Shop Drawings: Indicate seaming plans and floor patterns.
- D Verification Samples: Submit two samples, [] by [] inch in size illustrating color and pattern for each resilient flooring product specified.
- E Sustainable Design Submittal: Submit VOC content documentation for flooring and adhesives.
- F Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
- G Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.
- H Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
- I Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Flooring Material: [] square feet of each type and color.
 - 3. Extra Wall Base: [] linear feet of each type and color.
 - 4. Extra Stair Materials: Quantity equivalent to 5 percent of each type and color.

1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.
- B Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.
- C Testing Agency Qualifications: Independent firm specializing in performing concrete slab moisture testing and inspections of the type specified in this section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B Store all materials off of the floor in an acclimatized, weather-tight space.
- C Maintain temperature in storage area between 55 degrees F and 90 degrees F.
- D Protect roll materials from damage by storing on end.
- E Do not double stack pallets.

1.07 FIELD CONDITIONS

- A Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 SHEET FLOORING

2.02 TILE FLOORING

- A PVC-Free Resilient Tile - Type []: Mineral and thermoplastic polymer construction; ionomer-impregnated wear surface.
 - 1. Manufacturers:
 - a. Shaw Contract: <https://www.shawcontract.com/>
 - 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 3. VOC Content Limits: As specified in Section 01 61 16.
 - 4. Plank Tile Size: 6 by 48 inch.

5. Thickness: 0236 inch nominal.
 6. Static Load Resistance: 250 psi minimum, when tested as specified in ASTM F970.
 7. Pattern: [_____].
 8. Color: As indicated on drawings.
- B Static Control Tile - Type [____]: Homogeneous; color and pattern throughout thickness.
1. Manufacturers:
 - a. Mannington Commercial; [_____]: www.manningtoncommercial.com#sle.
 - b. Roppe Corporation; ESD Rubber Static Control Tile: www.roppe.com#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Minimum Requirements: Rubber tile complying with ASTM F1344, Class 1, Type B.
 3. Electrical Resistance:
 - a. Conductive Tile: Resistance between 25 kilohms and 1.0 megohms as tested in accordance with ASTM F150.
 - b. Dissipative Tile: Resistance between 1.0 megohms and 1000 megohms as tested in accordance with ASTM F150.
 4. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 5. VOC Content Limits: As specified in Section 01 61 16.
 6. Tile Size: 12 by 12 inch.
 7. Total Thickness: 0.125 inch.
 8. Pattern: [_____].
 9. Color: As indicated on drawings.
- C Feature Strips: Of same material as tile, [____] inch wide.

2.03 STAIR COVERING

- A Stair Treads with Integral Risers: Rubber; full height of riser, full width and depth of tread in one piece; tapered thickness.
1. Manufacturers:
 - a. Johnsonite, a Tarkett Company; [_____]: www.johnsonite.com.
 - b. Mannington Commercial; [_____]: www.manningtoncommercial.com#sle.
 2. Minimum Requirements: Comply with ASTM F2169, Type TS, rubber, vulcanized thermoset.
 3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 4. Nominal Thickness: 0.1875 inch.
 5. Nosing: Square.
 6. Striping: 2 inch wide contrasting color abrasive strips.
 7. Tread Texture: Smooth.
 8. Tread Pattern: [_____].
 9. Color: As indicated on drawings.

2.04 RESILIENT BASE

- A Resilient Base - Type [____]: ASTM F1861, Type TS rubber, vulcanized thermoset; style as scheduled.
1. Manufacturers:
 - a. Johnsonite, a Tarkett Company; [_____]: www.johnsonite.com#sle.
 - b. Mannington Commercial; [_____]: www.manningtoncommercial.com#sle.
 - c. Roppe Corporation; Contours Profiled Wall Base System: www.roppe.com#sle.

- d. Substitutions: See Section 01 60 00 - Product Requirements.
- 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
- 3. Height: 4 inch.
- 4. Thickness: 0.125 inch.
- 5. Finish: Satin.
- 6. Length: Roll.
- 7. Color: As indicated on drawings.

2.05 ACCESSORIES

- A Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
 - 1. VOC Content Limits: As specified in Section 01 61 16.
- C Adhesive for Rubber Flooring:
 - 1. Manufacturers:
 - a. H.B. Fuller Construction Products, Inc; TEC Flexera Premium Universal Adhesive: www.tecspecialty.com/#sle.
 - b. Loba-Wakol, LLC; WAKOL D 3120 PVC Adhesive: www.loba-wakol.com/#sle.
 - c. Stauf USA, LLC; D737 High-Tack: www.staufusa.com/#sle.
 - d. Substitutions: Section 01 6000 - Product Requirements.
- D Moldings, Transition and Edge Strips: Same material as flooring.
- E Copper Grounding Strips: Type and size as recommended by static control flooring manufacturer.
- F Filler for Coved Base: Plastic.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test in accordance with Section 09 05 61.
 - 2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
 - 3. Follow moisture and alkalinity remediation procedures in Section 09 05 61.
- D Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A Remove existing resilient flooring and flooring adhesives; follow the recommendations of RFCI (RWP).
- B Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

3.03 INSTALLATION - GENERAL

- A Starting installation constitutes acceptance of subfloor conditions.
- B Install in accordance with manufacturer's written instructions.
- C Adhesive-Applied Installation:
 - 1. Spread only enough adhesive to permit installation of materials before initial set.

2. Place copper grounding strip in conductive adhesive and apply additional adhesive to top side of strip before installing static control flooring. Allow strip to extend beyond flooring in accordance with static control flooring manufacturer's instructions. Refer to Section 26 05 26 for grounding and bonding to building grounding system.
 3. Fit joints and butt seams tightly.
 4. Set flooring in place, press with heavy roller to attain full adhesion.
- D Loose-Laid Installation: Set flooring in place in accordance with manufacturer's instructions.
- E Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- F Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
1. Metal Strips: Attach to substrate before installation of flooring using stainless steel screws.
 2. Resilient Strips: Attach to substrate using adhesive.
- G Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- H Install flooring in recessed floor access covers, maintaining floor pattern.
- I At movable partitions, install flooring under partitions without interrupting floor pattern.
- J Install feature strips where indicated.
- 3.04 INSTALLATION - SHEET FLOORING
- A Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
- 3.05 INSTALLATION - TILE FLOORING
- A Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.
- B Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.
- C Install square tile to ashlar pattern. Allow minimum 1/2 full size tile width at room or area perimeter.
- D Install plank tile with a random offset of at least 6 inches from adjacent rows.
- 3.06 INSTALLATION - RESILIENT BASE
- A Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
- C Install base on solid backing. Bond tightly to wall and floor surfaces.
- D Scribe and fit to door frames and other interruptions.
- 3.07 INSTALLATION - STAIR COVERINGS
- A Install stair coverings in one piece for full width and depth of tread.
- B Adhere over entire surface. Fit accurately and securely.
- 3.08 CLEANING
- A Remove excess adhesive from floor, base, and wall surfaces without damage.
- B Clean in accordance with manufacturer's written instructions.
- 3.09 PROTECTION
- A Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 09 65 00

SECTION 09 68 13 - TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Carpet tile, fully adhered.
- B Removal of existing carpet tile.

1.02 RELATED REQUIREMENTS

- A Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B Section 01 74 19 - Construction Waste Management and Disposal: Reclamation/Recycling of new carpet tile scrap, removed carpet tile, and [_____].
- C Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.
- D Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

1.03 REFERENCE STANDARDS

- A ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials 2016 (Reapproved 2021).
- B ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- C ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring 2021.
- D ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride 2022.
- E ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes 2019a.
- F CRI 104 - Standard for Installation of Commercial Carpet 2015.
- G CRI (GLP) - Green Label Plus Testing Program - Certified Products Current Edition.
- H NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source 2023.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- D Sustainable Design Submittal: Submit VOC content documentation for adhesives.
- E Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and [_____].
- F Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- G Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.

- B Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.06 FIELD CONDITIONS

- A Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Tile Carpeting:
 1. Interface, Inc; [____]: www.interface.com/#sle.
 2. Mannington Commercial; [____]: www.manningtoncommercial.com/#sle.
 3. Bentley Mills: <https://www.bentleymills.com/>
 4. Mohawk Group; [____]: www.mohawkgroup.com/#sle.
 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A Tile Carpeting, Type [____]: Tufted, manufactured in one color dye lot.
 1. Product: [____] manufactured by [____].
 2. Tile Size: 18 by 18 inch, nominal.
 3. Thickness: [____] inch.
 4. Color: [____].
 5. Pattern: [____].
 6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
 7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
 8. VOC Content: Comply with Section 01 61 16.
 9. VOC Content: Provide CRI (GLP) certified product; in lieu of labeling, independent test report showing compliance is acceptable.
 10. Maximum Electrostatic Charge: 3 Kv. at 20 percent relative humidity.

2.03 ACCESSORIES

- A Edge Strips: Embossed aluminum, [____] color.
- B Adhesives:
 1. Compatible with materials being adhered; maximum VOC content as specified in Section 01 61 16.
- C Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.
- C Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
 1. Test in accordance with Section 09 05 61.
 2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.
 3. Follow moisture and alkalinity remediation procedures in Section 09 05 61.
- D Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A Remove existing carpet tile.
- B Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.

3.03 INSTALLATION

- A Starting installation constitutes acceptance of subfloor conditions.
- B Install carpet tile in accordance with manufacturer's instructions.
- C Blend carpet from different cartons to ensure minimal variation in color match.
- D Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
- F Locate change of color or pattern between rooms under door centerline.
- G Fully adhere carpet tile to substrate.
- H Trim carpet tile neatly at walls and around interruptions.
- I Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

- A See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B Remove excess adhesive without damage, from floor, base, and wall surfaces.
- C Clean and vacuum carpet surfaces.

END OF SECTION 09 68 13

SECTION 09 72 00 - WALL COVERINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Surface preparation and prime painting.
- B Wall covering and borders.

1.02 RELATED REQUIREMENTS

- A Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B Section 09 91 23 - Interior Painting: Preparation and priming of substrate surfaces.

1.03 REFERENCE STANDARDS

- A ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems 2020.
- B ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- C ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics 2020.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide data on wall covering and adhesive.
- C Shop Drawings: Indicate wall elevations with seaming layout.
- D Samples: Submit two samples of wall covering, ____by____ inch in size illustrating color, finish, and texture.
- E Manufacturer's Installation Instructions: Indicate special procedures.
- F Maintenance Data: Submit data on cleaning, touch-up, and repair of covered surfaces.
- G Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Wall Covering Materials: 25 linear feet of each color and pattern of wall covering; store where directed.
 - 3. Package and label each roll by manufacturer, color and pattern, and destination room number.

1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A Inspect roll materials at arrival on site, to verify acceptability.
- B Protect packaged adhesive from temperature cycling and cold temperatures.
- C Do not store roll goods on end.

1.07 FIELD CONDITIONS

- A Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or wall covering product manufacturer.
- B Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.
- C Provide lighting level of 80 ft candles measured mid-height at substrate surfaces.

PART 2 PRODUCTS

2.01 WALL COVERINGS

- A General Requirements:

1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
 2. Chemical and Stain Resistance: No visible staining or discoloration and no damage to surface texture when tested in accordance with ASTM D1308.
- B Wall Covering: [____], complying with the following:
1. Total Thickness: [____] mil.
 2. Total Weight: [____] oz/sq yd.
 3. Roll Width: [____] inches.
 4. Color: [____].
 5. Pattern: [____].
 6. Surface Texture: [____].
- C Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.
- D Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.
- E Substrate Primer and Sealer: Alkyd enamel type.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that substrate surfaces are prime painted and ready to receive work, and comply with requirements of wall covering manufacturer.
- B Measure moisture content of surfaces using an electronic moisture meter. Do not apply wall coverings if moisture content of substrate exceeds level recommended by wall covering manufacturer.
- C Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet nor vary at a rate greater than 1/16 inch/ft.

3.02 PREPARATION

- A Fill cracks in substrate and smooth irregularities with filler; sand smooth.
- B Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.
- C Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- D Surfaces: Correct defects and clean surfaces that affect work of this section. Remove existing coatings that exhibit loose surface defects.
- E Marks: Seal with shellac those that may bleed through surface finishes.
- F Apply one coat of primer sealer to substrate surfaces. Allow to dry. Lightly sand smooth.
- G Vacuum clean surfaces free of loose particles.

3.03 INSTALLATION

- A Apply adhesive and wall covering in accordance with manufacturer's instructions.
- B Apply adhesive to wall surface immediately prior to application of wall covering.
- C Use wall covering in roll number sequence.
- D Razor trim edges on flat work table. Do not razor cut on gypsum board surfaces.
- E Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.
- F Butt edges tightly.
- G Overlap adjacent panels as recommended by manufacturer.
- H Horizontal seams are not acceptable.
- I Do not seam within 2 inches of internal corners or within 6 inches of external corners.

- J Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.
- K Do not install wall covering more than 1/4 inch below top of resilient base.
- L Cover spaces above and below windows, above doors, in pattern sequence from roll.
- M Where wall covering tucks into reveals, or metal wallboard or plaster stops, apply with contact adhesive within 6 inches of wall covering termination. Ensure full contact bond.
- N Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.04 CLEANING

- A Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.
- B Reinstall wall plates and accessories removed prior to work of this section.

3.05 PROTECTION

- A Do not permit construction activities at or near finished wall covering areas.

END OF SECTION 09 72 00

SECTION 09 91 13 - EXTERIOR PAINTING

PART 2 PRODUCTS

1.01 PAINTS AND FINISHES - GENERAL

- A Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.

PART 3 EXECUTION

2.01 PREPARATION

- A Clean surfaces thoroughly and correct defects prior to application.
- B Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.
- D Seal surfaces that might cause bleed through or staining of topcoat.
- E Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

2.02 APPLICATION

- A Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- B Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C Apply each coat to uniform appearance.
- D Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- E Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

END OF SECTION 09 91 13

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Surface preparation.
- B Field application of paints.
- C Materials for backpriming woodwork.
- D Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Surfaces inside cabinets.
 - 3. Prime surfaces to receive wall coverings.
 - 4. Mechanical and Electrical:
 - a. In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. In finished areas, paint shop-primed items.
 - c. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
 - d. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- E Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes, unless prime painting is required.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, and lead items.
 - 6. Marble, granite, slate, and other natural stones.
 - 7. Floors, unless specifically indicated.
 - 8. Ceramic and other tiles.
 - 9. Brick, architectural concrete, cast stone, integrally colored plaster, and stucco.
 - 10. Glass.
 - 11. Concrete masonry units in utility, mechanical, and electrical spaces.
 - 12. Acoustical materials, unless specifically indicated.
 - 13. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- A Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B Section 05 50 00 - Metal Fabrications: Shop-primed items.
- C Section 05 51 00 - Metal Stairs: Shop-primed items.
- D Section 09 91 13 - Exterior Painting.
- E Section 09 93 00 - Staining and Transparent Finishing: Wood substrates.
- F Section 09 96 00 - High-Performance Coatings.

- G Section 21 05 53 - Identification for Fire Suppression Piping and Equipment: Painted identification.
- H Section 21 05 53 - Identification for Fire Suppression Piping and Equipment: Color coding scheme for items to be painted under this section.
- I Section 22 05 53 - Identification for Plumbing Piping and Equipment: Painted identification.
- J Section 22 05 53 - Identification for Plumbing Piping and Equipment: Color coding scheme for items to be painted under this section.
- K Section 23 05 53 - Identification for HVAC Piping and Equipment: Painted identification.
- L Section 23 05 53 - Identification for HVAC Piping and Equipment: Color coding scheme for items to be painted under this section.
- M Section 26 05 53 - Identification for Electrical Systems: Painted identification.
- N Section 26 05 53 - Identification for Electrical Systems: Color coding scheme for items to be painted under this section.
- O Section 32 17 23.13 - Painted Pavement Markings: Painted pavement markings.
- P Section 33 16 00 - Water Utility Storage Tanks: Painting inside and outside of tanks.

1.03 DEFINITIONS

- A Comply with ASTM D16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

- A 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency current edition.
- B ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications 2019.
- C ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating 2005 (Reapproved 2017).
- D ASTM D4259 - Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application 2018.
- E ASTM D4260 - Standard Practice for Liquid and Gelled Acid Etching of Concrete 2005 (Reapproved 2017).
- F ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials 2020.
- G CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board 2020.
- H MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association Current Edition.
- I MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.
- J SCAQMD 1113 - Architectural Coatings 1977, with Amendment (2016).
- K SSPC V1 (PM1) - Good Painting Practice: Painting Manual Volume 1 2016.
- L SSPC V2 (PM2) - Systems and Specifications: Steel Structures Painting Manual Volume 2 2021.
- M SSPC-SP 1 - Solvent Cleaning 2015, with Editorial Revision (2016).
- N SSPC-SP 2 - Hand Tool Cleaning 2018.
- O SSPC-SP 3 - Power Tool Cleaning 2018.
- P SSPC-SP 6 - Commercial Blast Cleaning 2007.
- Q SSPC-SP 13 - Surface Preparation of Concrete 2018.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide complete list of products to be used, with the following information for each:

1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 2. MPI product number (e.g., MPI #47).
 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
 4. Manufacturer's installation instructions.
 5. If proposal of substitutions is allowed under submittal procedures, explanation of substitutions proposed.
- C Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
1. Where sheen is specified, submit samples in only that sheen.
 2. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens not required.
 3. Allow 30 days for approval process, after receipt of complete samples by Architect.
 4. Paint color submittals will not be considered until color submittals for major materials not to be painted, such as masonry, have been approved.
- D Certification: By manufacturer that paints and finishes comply with VOC limits specified.
- E Manufacturer's Instructions: Indicate special surface preparation procedures.
- F Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.
- G Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
 2. Extra Paint and Finish Materials: 1 gallon of each color; from the same product run, store where directed.
 3. Label each container with color in addition to the manufacturer's label.
- 1.06 QUALITY ASSURANCE
- A Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.
- B Applicator Qualifications: Company specializing in performing the type of work specified with minimum [_____] years experience and approved by manufacturer.
- 1.07 MOCK-UP
- A See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
 - B Provide panel, 10 feet long by 10 feet wide, illustrating paint color, texture, and finish.
 - C Provide door and frame assembly illustrating paint color, texture, and finish.
 - D Locate where directed by Architect.
 - E Mock-up may remain as part of the work.
- 1.08 DELIVERY, STORAGE, AND HANDLING
- A Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
 - B Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

- C Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.09 FIELD CONDITIONS

- A Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F above the dew point, or to damp or wet surfaces.
- D Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.
- E Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- B Paints:
 - 1. Benjamin Moore: www.benjaminmoore.com
 - 2. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
- C Primer Sealers: Same manufacturer as top coats.
- D Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL

- A Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 3. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
 - 4. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 5. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B Volatile Organic Compound (VOC) Content: Comply with Section 01 61 16.
- C Flammability: Comply with applicable code for surface burning characteristics.
- D Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- E Colors: To be selected from manufacturer's full range of available colors.
 - 1. Selection to be made by Architect after award of contract.
 - 2. Allow for minimum of three colors for each system, unless otherwise indicated, without additional cost to Owner.
 - 3. Extend colors to surface edges; colors may change at any edge as directed by Architect.

4. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling under which they are mounted.
5. In utility areas, finish equipment, piping, conduit, and exposed duct work in colors according to the color coding scheme indicated.

2.03 PAINT SYSTEMS - INTERIOR

- A Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry units, brick, wood, plaster, uncoated steel, shop primed steel, galvanized steel, aluminum, and acoustical ceilings.
1. Two top coats and one coat primer.
 2. Top Coat(s): High Performance Architectural Interior Latex; MPI #138, 139, 140, 141, or 142.
 - a. Products:
 - 1) Benjamin Moore: Ultra Spec 500 Acrylic Zero VOC Eggshell Enamel (0g/L)
 - 2) Sherwin-Williams ProMar 200 Zero VOC Interior Latex Egg Shell, B20W2600 (<50 g/L VOC)

PART 3 EXECUTION

3.01 EXAMINATION

- A Do not begin application of paints and finishes until substrates have been adequately prepared.
- B Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D Test shop-applied primer for compatibility with subsequent cover materials.
- E Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
1. Gypsum Wallboard: 12 percent.
 2. Plaster and Stucco: 12 percent.
 3. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
 4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
 5. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 PREPARATION

- A Clean surfaces thoroughly and correct defects prior to application.
- B Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C Remove or repair existing paints or finishes that exhibit surface defects.
- D Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- E Seal surfaces that might cause bleed through or staining of topcoat.
- F Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- G Concrete:
1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 2. Clean surfaces with pressurized water. Use pressure range of 1,500 to 4,000 psi at 6 to 12 inches. Allow to dry.

3. Clean concrete according to ASTM D4258. Allow to dry.
 4. Prepare surface as recommended by top coat manufacturer and according to SSPC-SP 13.
- H Masonry:
1. Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
 2. Prepare surface as recommended by top coat manufacturer.
 3. Clean surfaces with pressurized water. Use pressure range of 600 to 1,500 psi at 6 to 12 inches. Allow to dry.
- I Concrete Floors and Traffic Surfaces: Remove contamination, acid etch and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- J Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- K Plaster: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- L Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- M Galvanized Surfaces:
1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 2. Prepare surface according to SSPC-SP 2.
- N Ferrous Metal:
1. Solvent clean according to SSPC-SP 1.
 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
 3. Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.
- O Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- P Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with clear sealer.
- Q Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.
- 3.03 APPLICATION
- A Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- D Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- F Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- G Sand wood and metal surfaces lightly between coats to achieve required finish.
- H Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

I Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.

J Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

A See Section 01 40 00 - Quality Requirements, for general requirements for field inspection.

B Owner will provide field inspection.

3.05 CLEANING

A Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

A Protect finishes until completion of project.

B Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 91 23

SECTION 09 93 00 - STAINING AND TRANSPARENT FINISHING

PART 2 PRODUCTS

1.01 STAINS AND TRANSPARENT FINISHES - GENERAL

A Finishes:

1. Provide finishes capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
3. Supply each finish material in quantity required to complete entire project's work from a single production run.
4. Do not reduce, thin, or dilute finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

END OF SECTION 09 93 00

SECTION 10-14 00-SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provide unit pricing for all sign types, which includes the cost of installation, per sign.

1.2 SUMMARY

- A. Provide interior and exterior signage of the size, material, images, and arrangements made up of the components and construction as indicated in the Construction Document Drawings, Sign Location Plans and associated Message Schedule.
- B. Perform all work including, but not limited to, the engineering, development, testing, fabrication, transportation, assembly, and erection necessary to provide complete signage and graphics:
 - 1. Water jet-cut bronze metal letters.
 - 2. Dimensional bronze channel letters.
 - 3. Steel framing for free-standing pylons.
 - 4. Direct printed graphics.
 - 5. Silk screen printing
 - 6. Applied electro-cut vinyl.
 - 7. Shop painting, coating, and finishing of fabricated elements.
 - 8. Cutting, routing, brushing and finishing bronze and aluminum.
 - 9. Include all framing, welding, hardware, fasteners, grout, accessories, miscellaneous materials and components required to complete this work.
 - 10. Large format color printing.
 - 11. Installation.
- C. Relate, adjust, and arrange signage and graphics together with fabrication and installation of related work existing as constructed and specified in other sections of Project where signage will be built upon, built into, or connected to other Project elements.
- D. Fill and patch adjacent conditions related to signage installations to match respective adjacent finishes.
- E. Provide protection for all signs during installation and until acceptance of this work.
- F. Remove all surplus materials, rubbish, and equipment upon completion of signage installations.

1.3 QUALITY ASSURANCE

- A. General

1. Materials, methods of fabrication, fitting, assembly, bracing, supporting, fastening, operating devices, and installation shall be in accordance with Construction Document Drawings and Specifications, approved submittals, and shall be of highest quality practices of the industry.
 2. All work shall be accurately and neatly fabricated, assembled, and erected.
 3. Work specified in this Section shall be closely related, adjusted, and arranged together with elements existing on Project or to be constructed on Project. Furnish all necessary templates and patterns required to fit other work. Furnish all items pertaining to fabrications that are to be built into work under other Sections. Supervise and be responsible for the proper location and installation of such built-in items.
- B. Fabricator and Installer Qualifications: Work of signage and graphics shall be fabricated and installed by an experienced architectural graphics fabricator or manufacturer who has continuously been engaged in work of equivalent scope, quality level, and fabrication standards for a minimum of seven (7) years. Fabricator must provide references (with contact names and phone numbers) for 3 projects within the last 3 years - at least one of equivalent scope.
- C. Field Measurements: Verify dimensions with work of other Sections, which adjoins the Signage work. All locations of signage must be inspected on-site, field measured and documented by the fabricator. Field measurement documents must be forwarded to the Architect and the Contractor one month prior to installation as part of the shop drawing process.
1. Measurements of adjoining work shall be taken, so that the Signage work shall fit closely into the spaces provided
 2. If any unusual conditions are encountered, Shop Drawings showing the nature and location of conditions shall be submitted to the Architect for review prior to fabrication.
- D. Source Limitations: Obtain each sign type through one source from a single manufacturer.
- E. Shop Assembly: Insofar as practicable, fitting and assembly of work shall be done in shop.
1. Work that cannot be permanently shop assembled, shall be completely assembled, marked and disassembled in shop before shipment to ensure proper assembly in field.
 2. Shop fabricated items shall properly fit the field condition. In the event that shop-fabricated items do not fit the field condition, the item shall be returned to the shop for correction.
- F. Certificates of Compliance of Manufacture: Certificates of Compliance of Manufacture and Warrantees on materials and manufacturing will be required.
- G. Applicable Standards and References: Materials and work shall conform to the codes and requirements specified in Project Specifications and:
1. "Specifications for Structures of Aluminum Alloys" issued by the Aluminum Association of America.
 2. "Metal Finishes Manual for Architectural and Metal Products" issued by National Association of Architectural Metal Manufacturers.
 3. "Code for Welding in Building Construction," issued by the American Welding Society (AWS Code).
 4. Specified references to Specification of American Society for Testing Materials, (ASTM).
 5. "ADA Accessibility Guidelines for Buildings and Facilities" issued by the Department of Justice, United States Government.
 6. ICC/ANSI A117.1 – 2003. Chapter 7 Communication Elements and Features.

7. Any applicable building, public works and zoning codes and ordinances as required by the local Authority Having Jurisdiction.

1.4 SUBMITTALS

- A. General: Refer to and comply with Shop Drawings, Product Data, Samples and these Project Specifications for procedures.
- B. Supplier/Fabricator and Installer Qualifications: Submittal to include identification of previous experience in custom signage fabrication of equal complexity and scale, one reference from each of those same projects, sample shop drawings from each of those projects. Refer to "Fabrication and Installer Qualifications" under PART 1 Article "Quality Assurance" for additional criteria.
- C. Supplier/Fabricator to submit production schedule upon award of contract.
- D. Shop Drawings: Submit drawings and details to fully illustrate all signage types and items of work of this Section.
 1. Details need to show materials, thickness, finishes, hardware, dimensions, construction, relation and modifications to adjoining construction, foundations, blocking, structural coordination, erection details, profiles, jointing, sign orientation and all other conditions. They shall indicate both shop and on-site connections, anchorage, diagrams and details indicating provision for movement, hinge connections, latching devices, fastening and sealing methods, hanging and support methods, wind loads, electrical connections, and all other pertinent information. Patterns or molds of each custom extrusion required.
 2. Provide for review full-scale typographic layout representative of each different sign type demonstrating exact type font, size, letter spacing, line spacing and exact arrow and symbol artwork in position. Layout prints must be solid black type on white paper. Provide sign types with numerous unique layouts (i.e. Door signs: men, women, family, etc.) show each unique layout. For exceptionally large signs, scaled drawings may still be necessary.
- E. Product Data: Submit manufacturer's technical data and installation instructions for all materials, components, and applied finishes of signage and graphics work. Include the following:
 1. Metal materials, Bronze and Aluminum.
 2. Tempered low-iron glass.
 3. Each manufactured component used within fabricated assemblies.
 4. Shop applied painting and priming systems.
 5. Adhesives and sealants.
 6. Vinyl materials.
 7. Installation accessory materials, including mechanical fasteners, standoff hardware and cable termination assemblies for each type and condition as applicable.
- F. Samples: Three (3) sets of each material sample shall be submitted for review and approval. Submitted samples shall be representative of the workmanship and finishes for all sign work and shall serve as a standard in completed sign approvals and re-orders. Painted finishes must include priming, paint and satin clear coating.
 1. Each material, resolution, finish, and color: 6"x 6" minimum size for final record set.
 2. Three (3) sets of each sample will be required for record set.
 - a. Medium Oxidized Bronze
 - b. Light Oxidized Bronze

- c. Aluminum (painted in each color)
 - d. Tempered low-iron glass
 - e. Opaque and Reflective Electro-cut Vinyl Sheeting (each color)
 - f. POP Touch Acrylic
 - g. Vinyl Wallcovering for custom large-format printing
 - h. All Extrusions and Trim Angles, finishes as appropriate
 - i. Each material component of assembly including each type of hardware, gasket and sealant material for color selection by Graphics Consultant.
 3. Others as required by Graphics Consultant to confirm selections with design requirements.
- G. Templates: Submit full-scale typographic templates for each layout. Templates to show every typical message. Templates must be continuous computer printouts, solid black type on white paper.
 1. Graphics Consultant will supply electronic files of templates, upon written request.
- H. Prototypes of Signs: Submit a finished sign, for each sign type, full size, ready to mount, for review by the Graphics Consultant and Architect. All approved signs shall be considered a standard for other fabricated signage elements. Full size approved prototypes may be used for installations.
 1. The following list of sign types shall be fabricated and installed at the building in the appropriate locations for final review by the Owner, the Construction Manager, Architect and the Graphics Consultant:
 - a. Type EX1
 - b. Type EX3
 - c. Type TY1
 - d. TypeDY2
 - e. Type ID1 (one sample letter)
 - f. Type ID2 (one sample word)
 - g. Type ID4 (one sample letter)
 - h. Type ID5 (one sample letter)
 - i. Type E1 (one sample number)
 - j. Type DR2
 - k. Type DR3 (one sign)
 - l. Type ML1 (a 2' wide vertical swath of each wall graphic to demonstrate correct color output. Additional swaths for each graphic may be required to fine-tune color.)
 - m. Type ML2 (a 2' wide vertical swath of each wall graphic to demonstrate correct color output. Additional swaths for each graphic may be required to fine-tune color.)
 2. All prototype signs MUST be reviewed and approved prior to the production of the remaining signs and graphics. If the sign fabricator proceeds without the Graphics Consultant's approval, then he does so at his own risk of rejection of the completed unapproved signs and or graphics.
- I. Contract Closeout Submittals
 1. All electronic files prepared by the Fabricator for the production of signage work of this Project shall be the property of the Owner, and shall be delivered to the Architect upon request.

2. All mechanicals, original artwork and electronic art files supplied by the Graphics Consultant remain the property of the Graphics Consultant and are temporarily supplied for reproduction purposes only.
3. Furnish four of each kind and size of tool required for removal of each kind of vandal-resistant fastener used for Project signage.
4. Supply copies of Product Maintenance Data, in quantities required per Division 01 Section "Closeout Procedures," for inclusion in the Project Maintenance Manual. This shall include, but not be limited to the following information:
 - a. Operating, cleaning, and maintenance instructions.
 - b. Finish materials with touch-up and refinishing instructions.
 - c. Catalogs and parts lists of components from respective manufacturers, including manufacturer's warranties.
 - d. Other pertinent information, data, and instructions that will be required by the Owner in order to maintain all architectural graphics in "like-new" condition.

1.5 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Profiles of exposed surfaces shall be maintained as indicated. All component sizes and thickness, connections, braces, anchors, sub-assemblies and accessories shall be engineered by the manufacturer to suit the specific condition. Where required by codes, Fabricator, as part of this work, shall obtain tests and certificates of conformance. Fabricator shall supply drawings, prepared, approved, and stamped by an Engineer registered in the State of Illinois.
- B. Provision for Thermal Movements: The work shall be designed and installed to provide for thermal movement of component materials without causing buckling, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other detrimental effects.
- C. Material Colors: All colors shall be custom, unless stated otherwise, matching samples or specifications selected or supplied by the Graphics Consultant.
- D. Graphics and Typeface:
 1. Provide for all signs and graphics as indicated on drawings and schedules.
 2. The typefaces shown for design and as indicated on the drawings are
 3. Acumin Variable Concept (AVC):
 - a. AVC Extra Light
 - b. AVC Light
 - c. AVC Regular
 - d. AVC Medium
 - e. AVC Bold
 - f. AVC Semicondensed
 - g. AVC Semicondensed Medium
 - h. AVC Semicondensed Semibold
 - i. AVC Semicondensed Bold
 - j. AVC Condensed Semibold
 4. Letter, word, and line spacing shall be in visual conformance with the layouts shown on the drawings.
 5. Graphics Consultant will supply graphic symbols, arrows symbols files in electronic format, Illustrator v. 2022 (or lower), upon written request.

6. Graphic letters, numbers, forms, and stencil cutting shall be visually clear and crisp, without rounded positive or negative corners, distortion, bleeding, running, or other irregularities. All edges and lines shall be true, square and plumb, and curves shall be true to radius and free of cut or ragged edges

1.6 DELIVERY, STORAGE AND HANDLING

- A. Finished Materials: Protect existing finishes and new signage finishes against soiling, staining or damage from scratches and abrasion. Maintain protection during construction and until Owner occupancy and use of Project or a designated portion of Project.
 1. Provide wrapping, strippage coatings or other means of protection which, when removed, will result in finish approval by the Architect.
 2. During construction, remove protection for visual observation of finish as directed by the Architect and replace to maintain protection.
- B. Metals, and Aluminum Sheets:
 1. Provide cushions at panels to prevent damage at all times during transport, storage, and handling. Protect faces from scratches and abrasion. Protect edges from chipping or other damage.
 2. Use special care in the fabrication and installation of plastic sheets to prevent scratching, staining, or other imperfections. Note that edge illumination by sunlight or other source will enhance any imperfections or scratches in the material that may cause rejection.

1.7 EXTENDED WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provision of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Warranty Period: 7 years unless specified otherwise herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Metals:
 1. Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials by gaskets and/or use of protective coatings.
 2. Bronze Letters:
 - a. Thickness: 1/8" minimum.
 - b. Finish: Oxidized and Clear Coated. See drawings for details.
 - c. Water-jet cut
 - d. Edges: Standard edge treatment of 90 degrees.
 - e. Corners: Standard 90 degree, square.
 - f. Mounting Method: see drawings for details.

3. Aluminum frames: Alloy and temper recommended by aluminum producer and finisher for use and finish indicated, and with not less than the strength and durability of alloy and temper designated below:
 - a. Extruded Bars and Shapes: ASTM B221, 6063-T6 alloy, 1/8" thickness minimum, with high quality extrusion dies to produce minimum of die lines.
 - b. Sheets: ASTM B209 for all Sign Types requiring aluminum except use: 6061-T6 alloy, 1/8" thickness minimum, stretcher leveled and visually flat of best architectural quality.
 - c. Square and Rectangular Tubing: ASTM B221, 6063-T52 (Extruded), AMS-QQ-A-200/9 Type 2, sharp corners.
 - d. Extrusions: 6063-T52, AMS-QQ-A-200/9, sharp corners.
 - e. Channels: 6063-T52, AMS-QQ-A-200/9, sharp corners.
 - f. Angles: ASTM B 308, 6061-T6 (Extruded), AMS-QQ-A-200/16.
 - g. Finish: Satin, painted. See drawings for details.
 4. Bronze Brackets:
 - a. Finish: Light Oxidized
 - b. Custom fabricate to match details.
 - c. All screws are countersunk and finished to match finish.
 5. Mechanical Fasteners: Furnish of basic metal and alloy, matching finished color and texture as metal being fastened, unless otherwise indicated. Provide fasteners with rated holding power four (4) times design working load. Where exposed to view, fasteners shall be tamper-resistant.
 - a. For Aluminum frames: Aluminum or Stainless Steel to suit condition and as specified.
 - b. Welding Electrodes and Filler Metal: Type and alloy recommended by producer of metal to be welded for color match, strength, and compatibility in fabricated items.
- B. Adhesives and Sealants
1. Adhesives required in fabrication and installation shall be compatible with the materials to be laminated or adhered. Adhesives shall be as specified for fabrications and used in accordance with the recommendations of the manufacturer of the adhesives and the material to be laminated or adhered.
 2. Adhesives shall be of a type formulated not to deteriorate, discolor, de-laminate or fail in adhesion for any reason including exposure to heat, sunlight, weathering or other environmental conditions. Clear or light color types shall be non-yellowing.
 3. Adhesives shall not change the color of, stain, or in any way deteriorate the materials to which they are being applied.
 4. Epoxy adhesives, in addition to general requirements specified, shall be clear, two-component epoxy, thermal setting, and premium quality materials.
 5. No adhesives should be visible at any time on any of the sign types.
 6. Sealant: One-part silicone sealant, 20 to 30 Shore A hardness, clear or custom color as selected by Architect. "Silicone Sealant 1200" of General Electric or "999" by Dow Corning. Sealant primers and backing shall be as recommended by sealant manufacturer for condition of use.
- C. Vinyl Graphics: Avery Vinyl Film
1. Warranty: 9 Years.
 2. Exterior Grade

3. Graffiti-Resistant
 4. Colors:
 - a. SC 950-102 (White)
 - b. SC 950-190 (Black)
 - c. SC 900-861-W (Etchmark)
 - d. SC 950-440 (Red)
 - e. V 4000-190 (Black)
 - f. V 4000-101 (White)
 - g. V 4000-450 (Red)
 - h. V 2000-750 (Green)
 - i. V 2000-650 (Blue)
- D. Paints and Coatings: Primer, Color Coat, and Protective Coating Materials:
1. Painting System shall use paint products of one manufacturer to insure compatibility of primer and undercoats with topcoats.
 - a. Finish and color shall be as approved by the graphics consultant. See drawings for finish information.
 - b. Opaque Paints: Acrylic Polyurethane Paints
 - c. Polyurethane Top Coat Finish: Matthews Diamond Shield Protective Coating or equal.
 - d. Seal all painted surfaces with MAP (Matthews Acrylic Polyurethane) Clear.
 - e. Custom colors to be selected for each sign type and condition.
 - f. Fabricator must custom match specified interior designer's paint colors.
 - g. Paint colors:
 1. Matthews Paint MP 56334 (Choco Bronze Metallic)
 2. Matthews Paint MP 49025 (Leonardo Bronze Metallic)
 3. Matthews Paint MP 59647 (Black is Back)
 4. Matthews Paint MP 31645 (Designer White)
 5. Matthews Paint MP 46540 (Brazen Bronze Metallic)
 6. Matthews Paint MP 04836 (Obsidian)
 7. Matthews Paint MP 23966 (Crimson Red)
 8. Match Benjamin Moore 2148-70 (Mtn. Peak White)
 9. Match Benjamin Moore AF-665 (Silhouette)
- E. Large Format Digital Color Printing on Vinyl Wallcovering:
1. Artwork to be output in a minimum of a 6-color printer (CMYK + light magenta + light cyan) 600 x 1200 dpi output resolution, or better.
 2. Files to contain a minimum of 200 pixels per inch at final size.
 3. Artwork to be printed using UV protected inks.
 4. Show no dithering patterns or "stepping" of diagonal lines and fields.
 5. All outputs must match the specified PMS or CMYK colors.
 6. Output on to specified width (TBD) of (Wolf Gordon) vinyl wallcovering.
 7. Vinyl wall covering shall meet all federal specifications CCC-W408A and CFFA-W-101-D Quality Standard for Vinyl Coated Fabric Wall covering.
 8. The vinyl wall covering shall contain mildew inhibitors.
 9. Vinyl wall covering must be PVC-free.
 10. The adhesive used must be manufacturer's recommended adhesive and must contain mildew inhibitors.
 11. Wall surface shall be free from defects and imperfections that could show through the finished covered surface.
 12. Certified written 3-year warranty for ink jet graphics is required.

- F. Glass:
 - 1. Clear glass should be Starphire, low iron, low glare 3/8" thick tempered glass panels.
 - 2. All edges are polished and corners are eased.
- G. Plastics and Acrylic:
 - 1. POP Touch Acrylic is non-glare, clear legibility acrylic used for second surface graphics.
- H. Wind Pro Moveable Traffic Sign:
 - 1. 30" x 40"

2.2 FABRICATION STANDARDS

- A. General
 - 1. The Drawings and this Specification describe minimum requirements with respect to materials fabrication, installation and operation of the work items specified herein and should be used as a guide.
 - 2. Shop fabricate, finish, and assemble all signage. Work that cannot be permanently shop assembled shall be completely assembled, marked, and disassembled in shop before shipment to ensure proper assembly in field.
 - 3. The Fabricator shall note that the work of this Section consists of stock and custom designed components. All work shall be manufactured to conform to the profile and dimensional requirements of Contract Drawings and Specifications, unless otherwise approved by the Architect.
 - 4. All parts and all members of the work of this Section shall be the size, shape, and profile shown on the Drawings. Methods of fabrication, assembly and erection, unless otherwise specifically stated, shall be at the discretion of this Contractor/Fabricator.
 - 5. Fabricate signs and make connections in such a manner that major components may be removed and replaced if necessary.
 - 6. Follow materials manufacturer's specified procedures to comply with warranties. Specifically: application of cast vinyl to glass and PVC and curing of all painted surfaces.
 - 7. Exposed Work: In addition to requirements specified herein or shown on drawings, all surfaces exposed to view shall be clean, and free from dirt, stains, grease, scratches, distortions, waves, dents, buckles, tool marks, burrs, and other defects which mar appearance of finished work.
 - 8. Metal work exposed to view shall be straight and true to line or curve, smooth arises and angles as sharp as practicable without draft, miters formed in true alignment, profiles accurately intersecting, and with joints carefully matched to produce continuity of line and design.
 - 9. Exposed fastenings, where permitted by the Architect, shall be of the same material, color, and finish as the metal to which applied, unless otherwise indicated, and shall be of the smallest practical size.
 - a. Form ornamental metal to required shapes and sizes, with true curves, lines, and angles. Provide components in sizes and profiles indicated, but not less than that needed to comply with requirements indicated for structural performance.
 - b. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Drill and tap for required fasteners, unless otherwise indicated. Use concealed fasteners where possible.
 - c. Comply with AWS for recommended practices in shop welding and brazing. Provide welds and brazes behind finished surfaces without distorting or

- d. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration.
 - e. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- B. Graphic Components for Signage
1. This work shall be executed in such a manner that all edges and corners of finished letterforms are true and clean. Letterforms with rounded positive and negative corners, edge buildup, bleeding, transparency, crazing, saw tothing, bubbles, running, or other defects are not acceptable.
 2. All paints and primers required for etched and filled surfaces shall be a type made for the surface material on which it is applied and recommended for this application by the manufacturer of that product.
 - a. All colors shall be custom.
 - b. A list of final color numbers and samples will be supplied to the selected Fabricator on request.
 3. Letters, Symbols, Numbers, and Sign frames: Provide symbols and numbers to comply with the requirements indicated on the drawings for the manufacturing process, materials, finish, style, size and message content.
 - a. Cut-Out Letters, Symbols, and Numbers: Cut letters, symbols and numbers from solid plate material of thickness indicated. All letters, symbols and numbers to be water-jet cut to produce faces and returns are same finish. Produce precisely cut characters with square cut, smooth edges.
 - b. Silkscreened Graphics and Direct Printed second surface graphics: Apply graphics in a manner to produce clear, crisp letterforms in accordance with ink manufacturer's instructions and subsurface manufacturer's written instructions.
 4. Mounting Studs: Pin-mounting studs at interior and exterior and conditions shall be of solid stainless steel.
 - a. Sealant should be used to close up any openings around studs at wall.
 - b. Studs should be inset so as not to be visible.
 5. Adhesive and Sealant Applications
 - a. Visible joints shall be even and free from air bubbles and other defects.
 - b. Adhesives and sealants shall be provided where shown on Drawings or required. Sealant for each location and use shall be as indicated on the Drawings or as specified herein. In those locations where adhesive or sealant is necessary but is not indicated, material shall be of type approved by the Architect.
 - c. Protect all adjoining surfaces not to receive adhesives and sealants against staining by masking and other methods.
 - d. Surfaces on which adhesives or sealant are to be applied shall be smooth clean and free of dust, dirt, grease, fingerprints or other foreign matter.
 - e. When used for permanent installation, VHB adhesive shall be minimum width and thickness. No tape shall be closer than 1/8" from the edge of any component. The VHB tape used should be appropriate to the mounting surface according to the manufacturer's specifications.

- C. Metal Fabrications and Components
1. Edges and Cutting: Make edges and cuts accurate, clean, sharp, square, smooth, and free of burrs. Make cuts without deforming adjacent surfaces or materials.
 2. Holes: Drill or clearly punch holes (do not burn), so that holes will be accurate, clean, neat, and sharp without deforming adjacent surfaces.
 3. Connections: Make connections with tight joints capable of developing full strength of member, flush unless indicated otherwise formed to exclude water where exposed to water. Locate joints where indicated on drawings. Provide connections to allow for thermal movement of materials at locations approved by the Architect. For work exposed to view, use concealed fasteners (unless welded or other connections indicated) with joints accurately fitted, flush, and rigidly secured with hairline contacts (unless joints other than hairline indicated).
 - a. Threaded Fasteners (Bolts and Screws):
 1. Make threaded connections tight with threads entirely concealed.
 2. Where exposed to view, fasteners shall be of the tamper proof type with head size as specified or otherwise as small as possible.
 3. Welding:
 - b. Comply with recommendations of the American Welding Society using electrodes and methods recommended by the manufacturers of the metals being welded. Welds shall be continuous, except where spot welding is specifically permitted.
 - c. Welds exposed to view shall be ground flush and dressed smooth with and to match finish of adjoining surfaces so that joint will not be visible. Undercut metal edges where welds are required to be ground flush and dressed smooth.
 - d. All welds on or behind surfaces which will be exposed to view shall be executed to result in a finished surface free of imperfections such as pits, runs, splatter, cracks, warping, dimpling, depressions or other forms of distortion or discoloration. Remove weld spatter and welding oxides from all welded surfaces.
 1. Maintain continuity of the finish at exposed surfaces and edges near the exposed joints, which shall be sharp and square, without burrs, flattening, thinning, and easing of edge or other irregularities.
- D. Supplementary Parts Including Framing, Bracing, Supports, and the Like:
1. Provide as necessary to complete each item of work, even though such supplementary parts are not shown or specified. Use materials compatible with adjacent and connecting elements.
 2. Framing, plate reinforcing, supplementary framing or reinforcing, bracket assemblies, and the like, required for the support, framing, reinforcing, bracing, etc. of signage shall be of such sizes and shapes as indicated on the drawings and details, or as required to suit the conditions. Provide with all necessary supports and accessory items such as inserts, hangers, braces, struts, clip angles, anchors, bolts, nuts, welds etc., as required to properly and rigidly fasten, anchor or attach work of this Section in place and to the concrete, masonry, and other connecting and adjoining work.
- E. Coordination: Accurately cut, fit, drill and tap work of this Section to accommodate and fit other work on Project. Furnish or obtain, as applicable, templates and drawings to or from applicable trades for proper coordination of this work, particularly as related to electric, stone, concrete and other metal work.

- F. Finishes: All signage finishes shall be shop applied, unless otherwise authorized in writing by the Designers. Apply paint systems, for exposed conditions, in a dust and contaminant free environment and in accordance with paint manufacturer's written directions.
1. Finishing of Metal Fabrications
 - a. All exposed framing, bracing, and welds shall be cleaned and finished to a brushed finish as described below.
 - b. All surfaces indicated to be polyurethane topcoat painted, shall be cleaned and shop primed.
 - c. Application: Apply shop prime coat immediately after cleaning.
 - d. Paint all surfaces including edged, joints, holes, corners, returns, etc. to uniformly and completely cover the surface.
 - e. Include paint on surfaces, which will be concealed after shop assembly prior to such assembly.
 - f. Apply primer paint in accordance with approved paint manufacturer's printed instructions. The use of any thinners, adulterants or admixtures shall be only as stated in manufacturer's written instructions.
 - g. Touch-Up: In the shop, after assembly, and in the field (after installation of work of this Section) touch-up damaged or abraded exposed portions of shop prime paint with specified primer.
 2. Contour Cutting
 - a. Waterjet cutting shall be the method used for cutting muntz metal letters and acrylic letters.
 - b. CNC routing will not be acceptable for cutting letters.
 3. Brushed Metal Finishes
 - a. Muntz metal letters and framing must be horizontal brush finish as specified in the drawings. All brushed finishes on round tubes should run the length of the tube.
 4. Protective Coatings
 - a. Contact Condition Requiring Protection:
 1. Whenever dissimilar metals will be in contact.
 2. Wherever bronze and aluminum metals will be in contact with or embedded in concrete, cement, mortar, plaster, or masonry.
 - b. Application:
 1. Separate contact surfaces by coating each contact surface prior to assembly or installation with one coat of specified zinc chromate or zinc dust primer.
 2. Protective coatings shall be in addition to the specified shop prime paint. Mask off those surfaces not required to receive protective coating.
 - c. Acrylic Polyurethane Paint System. Painting system shall use paint products of one manufacturer to insure compatibility of primer and undercoats with topcoats. Finish, color and gloss shall be as approved by Designers.
 1. Paint types to provide satin finish.
 2. Electronically-cut frisket for masking and painting typography.
 3. Seal all paints with a satin clear sealant.
 4. Custom colors to be selected for each sign type and condition.
 5. Provide other materials or assembly components required for complete sign installation as approved by Designers for each condition of use.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install all signage square, plumb, straight, true to line or radius, accurately fitted and located, with flush tight hairline joints (except as indicated otherwise or to allow for thermal movement), with provisions for other work of Project, with provisions to allow for thermal movement, with provision to exclude water where exposed to the weather, and with attachment devices as required for secure and rigid installation.
2. Structural Loading Criteria: Install signage to provide items with capabilities to safely sustain or withstand stresses and strains to which materials and assembled work will be subjected. Comply with project loading and structural criteria indicated on the Drawings.
3. Coordinate completion of surrounding and adjacent construction to assure flush and, when applicable, waterproofed installation.
4. Signage installation should be completed in a six-week period. The signs should be ready for the Punch-list 4 weeks prior to the completion of the building.
5. Punch list: All installed signs will be reviewed by the Construction Manager, the Architect, and the Graphics Consultant. Any deficiency will be listed in detail and submitted for correction, repair or change as required.

B. Attachments

1. Unless indicated otherwise, work to be attached to concrete or masonry shall be anchored by bolts previously placed for signage installations into embedded metal inserts, or drilled in expansion shields, or anchored into concrete masonry units filled with grout prior to installation, with appropriate masonry anchors and adhesive. Minimum shear or tension capacities of 600 lbs must be maintained at each mechanical anchor.
2. Work attached to miscellaneous steel shall be anchored by bolts or screws to suit condition. Power-actuated fasteners are not permitted.
3. Work attached to gypsum wallboard or glass-fiber-reinforced plaster, shall be anchored by stainless steel self-tapping screws through the gypsum into a plywood blocking or steel strapping.
4. Spacers may be required, in combination with self-tapping screws, when attaching through metal profile panel.
5. All attachment devices for work exposed to view shall be concealed, unless otherwise indicated. Where bolts or screws are permitted in work exposed to view, they shall match adjacent surfaces.
6. All attachment devices shall be of type, size, and spacing to suit condition and as approved by Architect. Provide shims, slotted holes, or other means necessary for leveling, plumbing, and other required adjustments.
7. Do all necessary drilling, tapping, cutting or other preparation or surrounding construction in the field accurately, neatly and as necessary for the attachment and support of signage. Under no circumstances shall attachments to other work affect the structural integrity or exposed finish of that work.

C. Installation Procedures: Locate signs where indicated, using mounting methods specified. Install level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.

1. Wall-Mounted Panel Signs: Attach using methods indicated below:
 - a. Shim Plate Mounting: Provide 1/8-inch-thick concealed aluminum shim plates with predrilled and countersunk holes. Attach plate to substrate with fasteners and anchors. Attach sign to the plate using the method specified above.

2. Bracket-Mounted Units: Provide custom bracket extrusions, fittings, and hardware as appropriate for signs that project at right angles from walls and ceilings. Attach brackets and fittings securely with concealed fasteners and anchoring devices.
3. Dimensional Letters and Numbers: Mount characters using methods recommended for letter form, type of mounting, wall construction, and condition of exposure indicated. Provide heavy paper template to establish letter spacing and to locate holes for fasteners.
 - a. Flush Mounting: Backs in contact with wall or glass surface.
 - b. Projected Mounting: At distance from wall surface indicated.
 - c. Stud Mounting: For freestanding letters
 - d. Concealed Mounting: Use threaded studs into tapped lugs on the back of the plaque. Set in predrilled holes filled with quick-setting cement.
4. Provide supplemental sealants installation where required to make all exterior installation work of signage and adjacent conditions fully waterproof. Provide exterior sealants at adjacent conditions in accordance with Project Specifications, Joint Sealants. Use only sealants, which have the physical and chemical compatibility for use with adjacent material.

3.2 PROTECTION AND CLEANING

- A. Protect all signage and graphics work from damage during transportation, storage at job site during erection, and during subsequent construction activities. Exposed metal surfaces shall be wrapped with heavy reinforced, non-staining paper or non-staining strippable coatings or protected by other approved methods. After installation, provide additional temporary protection as required to protect work of the Section from damage during subsequent construction activities.
- B. After completion of the work of this Section and the work of adjacent trades, or at such times as directed by the Architect, all temporary protection shall be removed and the exposed surfaces of all work of this Section shall be cleaned and left free of smears, scratches, and abrasions, to the satisfaction of the Architect. Any damages to finishes shall be repaired at no additional cost to Authority. In the event damage is not repairable, remove and replace such items at no additional cost to Authority.

END OF SECTION 10 14 00

SECTION 10 21 13.13 - METAL TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Metal toilet compartments.
- B Urinal and Vestibule screens.

1.02 RELATED REQUIREMENTS

- A Section 05 12 00 - Structural Steel Framing: Concealed steel support members.
- B Section 05 50 00 - Metal Fabrications: Concealed steel support members.
- C Section 06 10 00 - Rough Carpentry: Blocking and supports.
- D Section 10 28 00 - Toilet, Bath, and Laundry Accessories.

1.03 REFERENCE STANDARDS

- A ASTM A424/A424M - Standard Specification for Steel, Sheet, for Porcelain Enameling 2018.
- B ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall, floor, and ceiling supports, door swings.
- C Product Data: Provide data on panel construction, hardware, and accessories.
- D Samples: Submit two samples of partition panels, ____x____ inch in size illustrating panel finish, color, and sheen.
- E Manufacturer's Installation Instructions: Indicate special procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Metal Toilet Compartments:
 - 1. All American Metal Corp - AAMCO; [____]: www.allamericanmetal.com/#sle.
 - 2. ASI Accurate Partitions; Stainless Steel: www.asi-accuratepartitions.com/#sle.
 - 3. ASI Global Partitions; Stainless Steel: www.asi-globalpartitions.com/#sle.
 - 4. General Partitions Mfg. Corp; [____]: www.generalpartitions.com/#sle.
 - 5. Hadrian; Hadrian - Standard Series - Powder Coated: www.hadrian-inc.com/#sle.
 - 6. Substitutions: Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.

2.03 COMPONENTS

- A Toilet Compartments: Powder coated steel, floor-mounted unbraced.
- B Doors, Panels, and Pilasters: Sheet steel faces, pressure bonded to sound deadening core, formed and closed edges; corners made with corner clips or mitered, welded, and ground smooth.
 - 1. Panel Faces: 20 gauge, 0.0359 inch.
 - 2. Door Faces: 22 gauge, 0.0299 inch.
 - 3. Pilaster Faces: 20 gauge, 0.0359 inch.

4. Reinforcement: 12 gauge, 0.1046 inch.
 5. Internal Reinforcement: Provide in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
- C Door and Panel Dimensions:
1. Thickness: 1 inch.
 2. Door Width: 24 inch.
 3. Door Width for Handicapped Use: 36 inch , out-swinging.
 4. Height: 58 inch.
- D Pilasters: 1-1/4 inch thick, of sizes required to suit compartment width and spacing.
- E Urinal Screens: Wall mounted with two panel brackets, and floor-to-ceiling vertical upright consisting of pilaster anchored to floor and ceiling.
- F Urinal Screen Splash Panels: Stainless steel sheet 30 inch wide by 42 inch high mounted on partitions adjacent to urinals. Fasten with stainless steel screws spaced 8 inches on center.

2.04 ACCESSORIES

- A Pilaster Shoes: Formed chromed steel with polished finish, 3 inch high, concealing floor fastenings.
1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
 2. Provide ceiling attachment using two adjustable hanging studs, attached to above-ceiling framing.
- B Head Rails: Hollow chrome-plated steel tube, 1 by 1-5/8 inch size, with anti-grip strips and cast socket wall brackets.
- C Brackets: Polished chrome-plated non-ferrous cast metal.
- D Attachments, Screws, and Bolts: Stainless steel , tamper proof type.
1. For attaching panels and pilasters to brackets: Through-bolts and nuts ; tamper proof.
- E Hardware: Polished chrome plated non-ferrous cast metal:
1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
 2. Nylon bearings.
 3. Thumb turn or sliding door latch with exterior emergency access feature.
 4. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
 5. Coat hook with rubber bumper; one per compartment, mounted on door.
 6. Provide door pull for outswinging doors.

2.05 FINISHING

- A Powder Coated Steel Compartments: Clean, degrease, and neutralize. Follow immediately with a phosphatizing treatment, prime coat and two finish coats powder coat enamel.
- B Color: [_____].

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify existing conditions before starting work.
- B Verify that field measurements are as indicated.
- C Verify correct spacing of and between plumbing fixtures.
- D Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION

- A Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters.
- C Attach panel brackets securely to walls using anchor devices.
- D Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

- E Field touch-up of scratches or damaged enamel finish will not be permitted. Replace damaged or scratched materials with new materials.

3.03 TOLERANCES

- A Maximum Variation From True Position: 1/4 inch.
- B Maximum Variation From Plumb: 1/8 inch.

3.04 ADJUSTING

- A Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B Adjust hinges to position doors in partial opening position when unlatched. Return out swinging doors to closed position.
- C Adjust adjacent components for consistency of line or plane.

END OF SECTION 10 21 13.13

SECTION 10 22 39 - FOLDING PANEL PARTITIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A Top-supported folding panel partitions, horizontal opening.

1.02 RELATED REQUIREMENTS

A Section 06 10 00 - Rough Carpentry: Wood blocking and track support shimming.

B Section 06 20 00 - Finish Carpentry: Product requirements for plastic laminate finish for installation by this section.

C Section 06 42 00 - Wood Paneling: Product requirements for wood veneer finish for installation by this section

D Section 08 71 00 - Door Hardware: Lock cylinders for panels

E Section 09 91 23 - Interior Painting: Field applied paint finish to panels.

1.03 REFERENCE STANDARDS

A ANSI A208.1 - American National Standard for Particleboard 2022.

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

C ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.

D ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.

E ASTM C1396/C1396M - Standard Specification for Gypsum Board 2017.

F ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing 2017.

G ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.

H ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).

I ASTM E413 - Classification for Rating Sound Insulation 2022.

J ASTM E557 - Standard Guide for Architectural Design and Installation Practices for Sound Isolation Between Spaces Separated by Operable Partitions 2012 (Reapproved 2020).

K ASTM E596 - Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures 1996 (Reapproved 2016).

L ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics 2020.

M HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood 2020.

N NEMA LD 3 - High-Pressure Decorative Laminates 2005.

O UL (FRD) - Fire Resistance Directory Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

A Preinstallation Meeting: Convene at project site seven calendar days prior to scheduled beginning of construction activities of this section to review section requirements.

1. Require attendance by representatives of installer.

2. Notify Architect four calendar days in advance of scheduled meeting date.

1.05 SUBMITTALS

A See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B Product Data: Provide data on partition materials, operation, hardware and accessories, electric operating components, track switching components, and colors and finishes available.

- C Design Data: Design calculations, bearing seal and signature of structural engineer licensed to practice in the State in which the Project is located, showing loads at points of attachment to the building structure.
- D Shop Drawings: Indicate opening sizes, track layout, details of track and required supports, static and dynamic loads, location and details of pass door and frame, adjacent construction and finish trim, and stacking depth.
- E Samples for Selection: Submit two samples of full manufacturer's color range for selection of colors.
- F Samples for Review: Submit two samples of surface finish, 12 by 12 inches size, illustrating quality, colors selected, texture, and weight.
- G Certificates: Certify that partition system meets or exceeds specified acoustic requirements.
- H Manufacturer's Instructions: Indicate special procedures.
- I Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods. Describe cleaning materials detrimental to finish surfaces and hardware finish.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products specified this section with minimum three years of documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Store products in manufacturer's unopened packaging until installation.

1.08 WARRANTY

- A See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B Correct defective Work within five year period after Date of Substantial Completion.
- C Provide two year manufacturer warranty against defects in material and workmanship, excluding abuse.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Folding Panel Partitions - Horizontal Opening:
 1. Hufcor, Inc; Series 600: www.hufcor.com/#sle.
 2. Modernfold, a DORMA Group Company: www.modernfold.com/#sle.
 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FOLDING PANEL PARTITIONS - HORIZONTAL OPENING

- A Folding Panel Partitions: Center opening; individual panels; side stacking; manually operated.
- B Panel Construction:
 1. Frame: 16 gauge, 0.0598 inch thick formed sheet steel frame top, bottom, jambs, and intermediates; welded construction, with acoustical insulation fill.
 2. Substrate: Gypsum board.
 3. Panel Substrate Facing: Steel sheet, manufacturer's standard thickness.
 4. Hinges: Continuous piano type, [] gauge, [] inch stainless steel.
 5. Hardware: Latching door handles of cast steel, satin chrome finish; lock cylinder keyed to building keying system; pull bars.
 6. Panel Properties:
 - a. Thickness With Finish: 3 inches.
 - b. Width: Equal widths.
 - c. Weight: 8 lb/sq ft.
- C Panel Finishes:

1. Facing: Plastic laminate.
2. Exposed Metal Trim: Clear anodized.

D Panel Seals:

1. Panel to Panel Seals: Grooved and gasketed astragals, with continuous flexible ribbed vinyl seal fitted to panel edge construction; color to match panel finish.
2. Acoustic Seals: Flexible acoustic seals at jambs, meeting mullions, ceilings, retractable floor and ceiling seals, and above track to structure acoustic seal.

E Suspension System:

1. Track: Formed steel; 1-1/4 by 1-1/4 inch size; thickness and profile designed to support loads, steel sub-channel and track connectors, and track switches.
2. Carriers: Nylon wheels on trolley carrier at top of every second panel, sized to carry imposed loads, with threaded pendant bolt for vertical adjustment.

F Performance:

1. Acoustic Performance:
 - a. Noise Reduction Coefficient (NRC): ASTM E596, NRC of 0.65 minimum.
 - b. Sound Transmission Class (STC): 38 to 42 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90, on panel size of 100 sq ft.
2. Surface Burning Characteristics of Panel Finish: Flame spread/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
3. Installed partition system track capable of supporting imposed loads, with maximum deflection of 1/360 of span.

G Accessories:

1. Ceiling Closure: White enameled ceiling closure; aluminum jamb and head molding, fittings and attachments, and intermediate meeting posts.
2. Pocket Enclosures: Door, frame, and trim to match adjacent walls.
3. Pass Door: Single door, 36 inch wide by 84 inch high opening; same design and construction as panel; fit door with perimeter acoustic gaskets, concealed closer, keyed lock, view window of [] glass, and tool operated floor seal.
4. Acoustic Sealant: As recommended by partition manufacturer.

2.03 MATERIALS

- A Aluminum Extrusions: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
- B Standard Gypsum Board: ASTM C1396/C1396M, 3/8 inch thick, maximum permissible length; ends square cut, square edges.
- C Coated Fabric: ASTM F793 Category VI, PVC-Free; color as selected by Architect from manufacturer's standard range.
- D Plastic Laminate: NEMA LD 3, HGS; color as selected; finish as selected.
 1. Product: [] manufactured by [].
- E Acoustic Insulation:
 1. Type: As required for acoustic performance indicated.
 2. Thickness: As required for acoustic performance indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that field measurements are as indicated.

- B Verify that required utilities are available, of the correct characteristics, in proper location, and ready for use.
- C Verify track supports are laterally braced and will permit track to be level within 1/4 inch of required position and parallel to the floor surface.
- D Verify floor flatness of 1/8 inch in 10 feet, non-cumulative.
- E Verify wall plumbness of 1/8 inch in 10 feet, non-cumulative.

3.02 INSTALLATION

- A Install partition in accordance with manufacturer's instructions and ASTM E557.
- B Fit and align partition assembly and pocket doors level and plumb.
- C Lubricate moving components.
- D Install acoustic sealant to achieve required acoustic performance.
- E Coordinate electrical connections.

3.03 ADJUSTING

- A Adjust partition assembly to provide smooth operation from stacked to full open position. Do not over-compress acoustic seals.
- B Visually inspect partition in full extended position for light leaks to identify a potential acoustical leak.
- C Adjust partition assembly to achieve lightproof seal.

3.04 CLEANING

- A Clean finish surfaces and partition accessories.

3.05 CLOSEOUT ACTIVITIES

- A Demonstrate operation of partition and identify potential operational problems.

END OF SECTION 10 22 39

SECTION 10 26 41 - BALLISTICS RESISTANT PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Laminated fiberglass ballistics-resistant panels.

1.02 RELATED REQUIREMENTS

- A Section 06 10 00 - Rough Carpentry: Wood framing to receive ballistics-resistant panels.
- B Section 09 21 16 - Gypsum Board Assemblies: Metal framing to receive ballistics-resistant panels.
- C Section 09 22 16 - Non-Structural Metal Framing: Metal framing to receive ballistics-resistant panels.

1.03 ABBREVIATIONS AND ACRONYMS

- A AR: Abrasion Resistant.
- B BHN: Brinell Hardness Number.
- C ITAR: International Traffic in Arms Regulations.
- D UHMWPE: Ultra High Molecular Weight Polyethylene.

1.04 REFERENCE STANDARDS

- A ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- B ISO 9001 - Quality Management Systems — Requirements 2015.
- C NIJ 0108.01 - Standard for Ballistic Resistant Protective Materials 1985.
- D UL 752 - Standard for Bullet-Resisting Equipment Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

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

1.06 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B Product Data: Manufacturer's current data sheets on each product to be used.
- C Shop Drawings: Details of installation of ballistics-resistant panels, including plan views, elevations, sections, and details of the proposed installation with attachment methods.
- D Samples: Submit two samples, minimum size 6 inches by 6 inches, for each product specified.
- E Certificates: Submit printed data to indicate compliance with following requirements.
 - 1. UL Listing verification and UL 752 Current Test Results as provided by Underwriters Laboratories.
 - 2. Manufacturer's third party certificate of registration with ISO 9001.
 - 3. Manufacturer's U.S. Dept. of State ITAR Statement of Registration.
- F Manufacturer's Instructions: Indicate preparation and installation.
- G Manufacturer's qualification statement.
- H Installer's qualification statement.
- I Warranty Documentation: Manufacturer warranty; ensure that forms have been completed in Owner's name and registered with manufacturer.
- J Specimen Warranty: Manufacturer warranty.

1.07 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.
 - 1. ISO 9001 certification.
 - 2. Current U.S. Dept. of State ITAR Statement of Registration.
- B Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.08 MOCK-UPS

- A See Section 01 40 00 - Quality Requirements for additional requirements.
- B Construct [_____] mock-up, [_____] ft long by [_____] ft wide, illustrating surface preparation techniques and application workmanship.
- C Locate where directed.
- D Mock-ups may remain as part of the work.

1.09 DELIVERY, STORAGE, AND HANDLING

- A Deliver and store products in manufacturer's unopened packaging bearing the brand name, manufacturer's identification, and required UL and NIJ certification labels until ready for installation.
- B Handle material with care to prevent damage. Stack panels flat, store inside under cover off the ground in a dry location, and protect from other construction activities.

1.10 FIELD CONDITIONS

- A Install products under environmental conditions (temperature, humidity, and ventilation) recommended by manufacturer.

1.11 WARRANTY

- A See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B Manufacturer Warranty: Provide ten year manufacturer warranty for materials and workmanship against defects commencing on the Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Laminated Glass Fiber Ballistics-Resistant Panels:
 - 1. Armortex; [____]: www.armortex.com/#sle.
 - 2. Insulgard Security Products; [____]: www.insulgard.com/#sle.
 - 3. Total Security Solutions; [____]: www.tssbulletproof.com/#sle.
 - 4. U.S. Bullet Proofing; USFA Fiberglass Wall Armor: www.usbulletproofing.com/#sle.
 - 5. Armorcore Bullet Resistant Fiberglass Panels: www.armorcore.com
 - 6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LAMINATED FIBER BALLISTICS-RESISTANT PANELS

- A General:
 - 1. Laminated fiber ballistics-resistant panels to be non-ricochet type. When struck by a bullet or projectile, the panels to delaminate in such a way that absorbs the energy, stops the projectile, and prevents ricochet or spalling.
 - 2. Ballistics Resistance of Joints: Equal to that of the panel.
- B Performance Requirements:
 - 1. Ballistics Resistance Rating: Listed and labeled as tested in accordance with UL 752 Level 7 (5.56 mm assault rifle) threat rating.
 - 2. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when tested in accordance with ASTM E84.
- C Laminated Fiber Panels:
 - 1. Material: Multiple layers of fiberglass woven roving bonded together with resin and compressed into flat rigid sheets.
 - 2. Panel Size: Maximum size to limit number of seams.
 - 3. Panel Thickness: Minimum thickness required for selected UL 752 threat level.

4. Panel Weight: Minimum weight required for selected UL 752 threat level.
5. Attachment Method: Mechanical fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verification of Conditions: Verify that substrates have been properly prepared.
- B If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A Clean surfaces thoroughly prior to installation of this work.
- B Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A Install panels in accordance with manufacturer's instructions and shop drawings and in proper relationship with adjacent construction.
 1. Maintain ballistics-resistive rating at panel junctures with concrete floor and roof slabs, bullet-resistive door and window frames, and required penetrations.
- B Reinforce panel joints with a minimum 4 inch wide back-up layer of ballistics-resistant material, centered on panel joints.
- C Secure panels using screws, bolts, or industrial adhesive.

3.04 PROTECTION

- A Protect installed panels from subsequent construction operations.
- B Touch-up, repair or replace damaged panels before Date of Substantial Completion.

END OF SECTION 10 26 41

SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Commercial toilet accessories.
- B Under-lavatory pipe supply covers.
- C Diaper changing stations.
- D Utility room accessories.

1.02 RELATED REQUIREMENTS

- A Section 08 83 00 - Mirrors: Other mirrors.
- B Section 09 30 00 - Tiling: Ceramic washroom accessories.
- C Section 10 21 13.13 - Metal Toilet Compartments.
- D Section 22 40 00 - Plumbing Fixtures: Under-lavatory pipe and supply covers.

1.03 ABBREVIATIONS AND ACRONYMS

- A PETG: Polyethylene Terephthalate Glycol.
- B PPE: Personal Protective Equipment.

1.04 REFERENCE STANDARDS

- A ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures 2011 (Reaffirmed 2022).
- C ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- D ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service 2015a (Reapproved 2019).
- E ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- F ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- G ASTM B86 - Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings 2018, with Editorial Revision (2021).
- H ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium 2017.
- I ASTM C1036 - Standard Specification for Flat Glass 2021.
- J ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- K ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror 2018.
- L ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping 2021.
- M ASTM D4802 - Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet 2016.
- N ASTM D5047 - Standard Specification for Polyethylene Terephthalate Film and Sheeting 2017.
- O ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- P ASTM F2285 - Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use 2004, with Editorial Revision (2016).
- Q ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).
- R ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.

1.05 ADMINISTRATIVE REQUIREMENTS

- A Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.06 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
- C Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Commercial Toilet, Shower, and Bath Accessories:
 - 1. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
 - 2. Bradley Corporation; [____]: www.bradleycorp.com/#sle.
 - 3. Substitutions: Section 01 60 00 - Product Requirements.
- B Under-Lavatory Pipe Supply Covers:
 - 1. Plumberex Specialty Products, Inc; [____]: www.plumberex.com/#sle.
- C Diaper Changing Stations:
 - 1. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
 - 2. Bradley Corporation; [____]: www.bradleycorp.com/#sle.
 - 3. Koala Kare Products; [____]: www.koalabear.com/#sle.
 - 4. Substitutions: 01 60 00 - Product Requirements.
- D Provide products of each category type by single manufacturer.

2.02 MATERIALS

- A Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.
- B Keys: Provide [_____] keys for each accessory to Owner; master key lockable accessories.
- C Stainless Steel Sheet: ASTM A666, Type 304.
- D Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- E Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
- F Zinc Alloy: Die cast, ASTM B86.
- G Acrylic Plastic Sheet: ASTM D4802.
- H PETG Plastic Sheet: ASTM D5047.
- I Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
- J Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.
- K Adhesive: Two component epoxy type, waterproof.
- L Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.
- M Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.03 FINISHES

- A Stainless Steel: Satin finish, unless otherwise noted.
- B Chrome/Nickel Plating: ASTM B456, SC 2, polished finish, unless otherwise noted.
- C Baked Enamel: Pretreat to clean condition, apply one coat primer and minimum two coats epoxy baked enamel.
- D Powder-Coated Steel: Clean, degrease, and neutralize. Follow immediately with a phosphatizing treatment, prime coat, and two finish coats of powder coat enamel.
- E Galvanizing for Items Other than Sheet: Comply with ASTM A123/A123M; galvanize ferrous metal and fastening devices.
- F Shop Primed Ferrous Metals: Pretreat and clean, spray apply one coat primer and bake.
- G Back paint components where contact is made with building finishes to prevent electrolysis.

2.04 COMMERCIAL TOILET ACCESSORIES

- A Toilet Paper Dispenser: Double roll, surface mounted, for coreless type rolls.
 - 1. Products:
 - a. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
 - b. Substitutions: Section 01 60 00 - Product Requirements.
- B Combination Towel Dispenser/Waste Receptacle: Recessed flush with wall, stainless steel; seamless wall flanges, continuous piano hinges, [____].
 - 1. Waste receptacle liner: Reusable, heavy-duty vinyl.
 - 2. Towel dispenser capacity: 400 C-fold.
 - 3. Waste receptacle capacity: 4 gallons.
 - 4. Products:
 - a. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
 - b. Substitutions: Section 01 60 00 - Product Requirements.
- C Automated Soap Dispenser: Liquid soap dispenser, wall-mounted, with stainless steel cover and window to gauge soap level, tumbler lock.
 - 1. Minimum Capacity: 48 ounces.
 - 2. Products:
 - a. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
 - b. Substitutions: Section 01 60 00 - Product Requirements.
- D Mirrors: Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.
 - 1. Annealed Float Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
 - 2. Size: [____].
 - 3. Frame: 0.05 inch angle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
 - 4. Backing: Full-mirror sized, minimum 0.03 inch galvanized steel sheet and nonabsorptive filler material.
 - 5. Fixed Tilt Mirrors: Minimum 3 inches tilt from top to bottom.
 - 6. Shelf: Stainless steel; gauge and finish to match mirror frame, turned down edges, welded to frame; 5 inches deep, full width of mirror.
 - 7. Shelves more than 36 inches wide: Concealed intermediate support.
 - 8. Products:
 - a. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.

- E Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.
 - 1. Minimum capacity: 250 seat covers.
 - 2. Products:
 - a. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
 - F Grab Bars: Stainless steel, smooth surface.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force, minimum.
 - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
 - c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.
 - e. Products:
 - 1) American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
 - 2) Substitutions: Section 01 60 00 - Product Requirements.
 - G Purse Shelf: Fold-down, with spring-loaded hinge designed to automatically return shelf to vertical position when not in use; 0.05 inch thick satin-finished stainless steel, with rolled or hemmed edge at shelf front.
 - 1. Products:
 - a. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
 - b. Substitutions: Section 01 60 00 - Product Requirements.
 - H Combination Sanitary Napkin/Tampon Dispenser: Stainless steel, surface-mounted.
 - 1. Door: Seamless 0.05 inch door with returned edges and tumbler lock.
 - 2. Cabinet: Fully welded, 0.03 inch thick sheet.
 - 3. Operation: No charge; no coin slots.
 - 4. Identify dispensers slots without using brand names.
 - 5. Minimum capacity: 15 napkins and 20 tampons.
 - 6. Products:
 - a. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
 - b. Substitutions: Section 01 60 00 - Product Requirements.
 - I Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.
 - 1. Products:
 - a. American Specialties, Inc; [____]: www.americanspecialties.com/#sle.
- 2.05 UNDER-LAVATORY PIPE AND SUPPLY COVERS
- A Specified in 22 40 00 - Plumbing Fixtures.
- 2.06 DIAPER CHANGING STATIONS
- A Diaper Changing Station: Wall-mounted folding diaper changing station for use in commercial toilet facilities, meeting or exceeding ASTM F2285.
 - 1. Material: Polyethylene.
 - 2. Mounting: Surface.
 - 3. Color: As selected.
 - 4. Minimum Rated Load: 250 pounds.
 - 5. Products:

- a. [_____].
- b. Substitutions: 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify existing conditions before starting work.
- B Verify exact location of accessories for installation.
- C For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.
- D Verify that field measurements are as indicated on drawings.
- E See Section [_____] for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

3.02 PREPARATION

- A Deliver inserts and rough-in frames to site for timely installation.
- B Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B Install plumb and level, securely and rigidly anchored to substrate.
- C Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
 - 1. Grab Bars: As indicated on drawings.
 - 2. Mirrors: 40 inch, measured from floor to bottom of mirrored surface.
 - 3. Other Accessories: As indicated on drawings.

3.04 PROTECTION

- A Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 28 00

SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Fire extinguishers.
- B Self-service reloadable fire extinguishers.
- C Fire extinguisher cabinets.

1.02 REFERENCE STANDARDS

- A ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).
- B NFPA 10 - Standard for Portable Fire Extinguishers 2022.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Fire Extinguishers:
 - 1. Activar Construction Products Group, Inc. - JL Industries; Cosmic Extinguisher - Multipurpose Chemical: www.activarcpg.com/#sle.
- B Fire Extinguisher Cabinets and Accessories:
 - 1. Activar Construction Products Group, Inc. - JL Industries; Ambassador Series: www.activarcpg.com/#sle.
 - 2. Larsen's Manufacturing Co; [_____]: www.larsensmfg.com/#sle.
 - 3. Oval Brand Fire Products; Cabinets for Low Profile Extinguishers: www.ovalfireproducts.com/#sle.

2.02 FIRE EXTINGUISHERS

- A Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B Water Type Fire Extinguishers: Stainless steel tank, pressurized, with premixed antifreeze solution, including hose and nozzle.
 - 1. Class: 2-A type.
- C Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Temperature range: Minus 40 degrees F to [____] degrees F.

2.03 SELF-SERVICE RELOADABLE FIRE EXTINGUISHERS

- A Self-Service Reloadable Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B Multipurpose Monoammonium Phosphate Dry Chemical Type Fire Extinguishers: Polymeric body, including discharge head, carbon dioxide cartridge, extinguisher agent cartridge and valve assembly.
 - 1. Temperature range: Minus 40 degrees F to 120 degrees F.

2.04 FIRE EXTINGUISHER CABINETS

- A Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
- B Cabinet Construction: Non-fire rated.
- C Fire Rated Cabinet Construction: One-hour fire rated.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.

3.02 MAINTENANCE - SELF-SERVICE FIRE EXTINGUISHERS

- A Monthly Inspections: Inspect self-service fire extinguishers on monthly basis in accordance with manufacturer's instructions, and requirements of the authorities having jurisdiction (AHJ).
- B Annual Inspections: Inspect self-service fire extinguishers on annual basis in accordance with manufacturer's instructions, and requirements of the authorities having jurisdiction (AHJ).
- C Inspection Certification Tag: Provide new tag indicating acceptable condition of fire extinguisher, date of inspection, and name of self-service inspector for each inspection.

END OF SECTION 10 44 00

SECTION 10 51 13 - METAL LOCKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A Metal lockers.

1.02 REFERENCE STANDARDS

A ADA Standards - 2010 ADA Standards for Accessible Design 2010.

1.03 SUBMITTALS

A See Section 01 30 00 - Administrative Requirements for submittal procedures.

B Shop Drawings: Indicate locker plan layout, numbering plan and combination lock code.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A Metal Lockers:

1. ASI Storage Solutions; [____]: www.asi-storage.com/#sle.
2. DeBourgh Manufacturing Co; Apex Series Lockers: www.debourgh.com/#sle.
3. Penco Products, Inc; [____]: www.pencoproducts.com/#sle.
4. Republic Storage Systems Co; [____]: www.republicstorage.com/#sle.
5. Tennsco Storage; Steel Lockers: www.tennsco.com/#sle.
6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LOCKER APPLICATIONS

A Box Lockers: Metal lockers, free-standing with matching closed base.

1. Configuration: as indicated on teh drawings.
2. Fittings: Size and configuration as indicated on drawings.
3. Ventilation: Manufacturer's standard louvers in door panel.
4. Locking: Padlock hasps, for padlocks provided by Owner.

B First Responder Duty Lockers: Metal lockers, free-standing wardrobe unit with drawer base.

1. Wardrobe Unit:
 - a. Width: 18 inches.
 - b. Depth: 18 inches.
 - c. Height: 61 inches.
2. Configuration: Single tier.
3. Fittings: Size and configuration as indicated on drawings.
4. Ventilation: Perforated side panels, doors, and back panels; integrated fan system.
5. Latching: Three-point, Cremone latching, with padlockable turn handle.
6. Locking: Padlock hasps, for padlocks provided by Owner.

2.03 METAL LOCKERS

A Locker Case Construction:

1. Heavy-Duty, Welded Construction: Made of formed and welded together sheet steel; metal edges finished smooth without burrs; baked enamel or powder coat finished inside and out.

B Latches and Door Handles: Manufacturer's standard.

C Locks: Locker manufacturer's standard type indicated in Applications article above.

PART 3 EXECUTION

3.01 INSTALLATION

A Install in accordance with manufacturer's instructions.

B Place and secure on prepared base.

- C Install lockers plumb and square.
- D Bolt adjoining locker units together to provide rigid installation.
- E Install fittings if not factory installed.
- F Replace components that do not operate smoothly.

3.02 CLEANING

- A Clean locker interiors and exterior surfaces.

END OF SECTION 10 51 13

SECTION 10 56 13 - METAL STORAGE SHELVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Case type shelving.
- B Case type cabinets.
- C Case type desks.
- D Shelving accessories.

1.02 RELATED REQUIREMENTS

- A Section 06 10 00 - Rough Carpentry: Blocking and reinforcement in walls for anchoring shelving units.
- B Section 09 21 16 - Gypsum Board Assemblies: Blocking and reinforcement in walls for anchoring shelving units.

1.03 REFERENCE STANDARDS

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

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Test Reports: Provide independent agency test reports documenting compliance with specified structural requirements.
- C Shop Drawings: Indicate location, type, and layout of shelving, including lengths, heights, and aisle layout, and relationship to adjacent construction.
 - 1. Indicate methods of achieving specified anchoring requirements.
- D Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and finishes.
- E Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 WARRANTY

- A See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B Provide one year manufacturer warranty covering defects of manufacturing and workmanship and rust and corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Case Type Shelving:
 - 1. ASI Storage Solutions; [_____]: www.asi-storage.com/#sle.
 - 2. Penco Products, Inc; [_____]: www.pencoproducts.com/#sle.
 - 3. SpaceSaver Corporation; [_____]: www.spacesaver.com/#sle.

2.02 SHELVING - GENERAL

- A See drawings for layout and sizes.
- B Anchors: Provide anchoring hardware to secure each shelving unit to floor and wall.
 - 1. Provide hardware of type recommended by manufacturer for substrate.

2.03 CASE TYPE SHELVING, CABINETS, AND DESKS

- A Case Type Shelving: Steel, closed sides and backs, with shelving brackets, shelving surfaces, and accessories as specified.
 - 1. Unit Width: 24 inches, overall.
 - 2. Shelf Capacity: Uniform distributed load of 50 psf, minimum.

3. Finish: Baked enamel, medium gloss.
- B Case Construction: Formed sheet metal comprising vertical support members and enclosure panels.
 1. Shelf Support Members: 16 gauge, 0.0598 inch, minimum; manufacturer's standard profile.
 2. Face Width of Exposed Vertical Supports: 2 inches, maximum.
 3. Panels: 24 gauge, 0.0239 inch, minimum.
 4. Connecting Hardware: Manufacturer's standard.
 5. Post Bases: Flat steel foot plate , with manufacturer's recommended adjustable leveling device.
- C Shelves: Formed sheet metal, finished on all surfaces with slots for dividers.
 1. Thickness: 16 gauge, 0.0598 inch, minimum.
 2. Shelf Edge Profile: Extending 3/4 inch, maximum, below top surface of shelf.
 3. Shelf Connection to Posts: Manufacturer's standard.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that substrate is level and that clearances are as specified.
- B Verify that walls are suitable for shelving attachment.
- C Do not begin installation until substrates have been properly prepared.
- D If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Anchor and reinforce as specified, as indicated on drawings, and as recommended by manufacturer.
- C Install shelving with shelf surfaces level and vertical supports plumb; adjust feet and bases as required.

END OF SECTION 10 56 13

SECTION 11 12 00 - PARKING CONTROL EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Parking access controls.
 - 1. Gate arm access control.
 - 2. Barrier gate access control.
- B Maintenance.

1.02 RELATED REQUIREMENTS

- A Section 03 30 00 - Cast-in-Place Concrete: Placement of anchors and components to be embedded in concrete.
- B Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- B ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- C ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- D ASTM F2200 - Standard Specification for Automated Vehicular Gate Construction 2020.
- E IEC 60950-1 - Information Technology Equipment – Safety - Part 1: General Requirements 2005, with Amendments (2013).
- F ITS (DIR) - Directory of Listed Products Current Edition.
- G NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- H NEMA MG 1 - Motors and Generators 2021.
- I NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems Current Edition, Including All Revisions.
- K UL (DIR) - Online Certifications Directory Current Edition.

1.04 SUBMITTALS

- A See Section 01 33 23 Shop Drawings, Product Data and Samples for submittal procedures.
- B Product Data: Provide data on operating equipment, characteristics, limitations, and temperature range of operation.
- C Shop Drawings: Indicate plan layout of equipment access lanes, curbing, mounting bolt dimensions, conduit and outlet locations, power requirements, and wiring diagrams.
- D Samples: Submit two samples of access cards illustrating size and coding method.
- E Manufacturer's Qualification Statement.
- F Installer's Qualification Statement.
- G Maintenance Contract
- H Operation Data: Submit data for operating equipment, clock timer, changing security access code, and remote operation.
- I Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- J Record Documentation: Record and submit actual locations of concealed conduit.

K Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Spare Parts: Two extra gate arm assemblies.

1.05 QUALITY ASSURANCE

A Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.06 WARRANTY

A See Section 01 78 36 Warranties and Bonds, for additional warranty requirements.

B Provide five year manufacturer warranty for operating equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A Parking Control Equipment:

1. Access Control Systems, LLC (ACS); [____]: www.acs-llc.com/#sle.
2. Automatic Systems; [____]: www.automatic-systems.us/#sle.
3. Falcon Eye Global Security, LLC; [____]: www.falconeyeglobal.com/#sle.
4. FlashParking; [____]: www.flashparking.com/#sle.
5. Lift Master: The Chamberlain Group LLC, www.liftmaster.com. Basis of Design.
6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DESCRIPTION

A Parking Control System: Automatic operation at entrance and automatic operation at exit.

B Provide protection against interference or damage by lightning or other electrical influences; include fuse, over-voltage protection, flash-over protection, and line filter.

C Entry: Automatic parking access control system is activated upon detection of coded card or key pad entry.

D Exit: Automatic parking access control system is activated upon detection of vehicle by infrared scanning device in pavement.

2.03 REGULATORY REQUIREMENTS

A Comply with applicable code and requirements of authorities having jurisdiction for emergency vehicle access.

B Products Requiring Electrical Connection: Listed and classified by ITS (DIR), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for purpose specified.

2.04 PERFORMANCE CRITERIA

A Operating Temperature: Minus 20 to 140 degrees F.

B Humidity: 15 to 95 percent RH noncondensing.

C Agency Certifications: IEC 60950-1.

D Rating: IEC 60950-1 under NEMA 250.

2.05 PARKING ENTRY/EXIT COMPONENTS

A Gate Arm - Entry and Exit Control: Provide equipment listed and labeled in compliance with UL 325 safety standards of gate operators.

1. Classification: Class I - Residential, vehicular gate operator with gate arm access control complying with UL 325.
2. Controls: Mechanism in compliance with UL 325 safety standards of gate operators, with cadmium coated steel components to raise and lower arm by instant reversing electric motor, enclosed speed reducer operated by self contained, plug-in replaceable controller with slip clutch to prevent

- breakage if arm is forced, and to permit manual operation and arm movement to stop and start at reduced speed if required.
- a. Activate automatic arm reversing switch if an obstacle is sensed when in downward motion.
 - b. Maintain gate arm in raised position until vehicle clears control area.
3. Control Cabinet: Steel, at least 14 gauge, 0.075 inch thick, with weather-tight seams and gaskets; thermally insulated to permit heater to maintain cabinet temperature to equipment operating minimum, flush access doors and panels, tamper proof hardware, master keyed locks, and concealed mounting bolts located inside of units.
 4. Gate Arm: Wood, 3/4 by 3-1/2 inch, one piece, with internal counterbalance, rubber bottom safety edge, automatic arm reversing switch, and [____]; with [____] ft extension and break line in arm.
 5. Gate Arm Length: As indicated on drawings.
 6. Gate Arm Height: Locate top of gate arm in down position at not more than 35 inches above pavement.
 7. Gate Arm Finish: Comply with applicable code for paint finish and markings on gate arm.
 8. Gate Arm Clamp: Cast metal, quick change clamp and hub bracket, to permit rapid replacement of gate arm without fitting or drilling.
 9. Pivot, Limit Stops, and Counterbalancing: Galvanized steel construction, enclosed in arm clamp, with oil impregnated bronze bearing.
 10. Gate Arm Support Post: Steel section; 37 inches high, 6 inches square, with 10 gauge, 0.135 inch minimum wall thickness; with welded and sealed steel post cap and base plate.
 - a. Finish: Baked enamel on steel, color as selected by Architect.
 11. Base Plate: Steel, welded to post, [____] inches larger than post, with anchor bolts into concrete slab.
 12. Manufacturers:
 - a. Automatic Systems; BL 229: www.automatic-systems.us/#sle.
 - b. Lift Master www.liftmaster.com (Basid)
- B Barrier Gate - Entry and Exit Control:** Provide equipment listed and labeled in compliance with UL 325 safety standards of gate operators and ASTM F2200 construction standards.
1. Classification: Class II - Commercial/General Access, for vehicular gate operator with barrier gate access controls complying with UL 325.
 2. Type of Gate: Vehicular horizontal slide gate.
 3. Controls: Mechanism in compliance with UL 325 safety standards of gate operators, with cadmium coated steel components to move gate by instant reversing electric motor, enclosed speed reducer operated by self contained, plug-in replaceable controller with slip clutch, and to permit manual operation and gate movement to stop and start at reduced speed if required.
 - a. Activate automatic gate reversing switch if an obstacle is sensed while gate is in motion.
 - b. Maintain gate in open position until vehicle clears control area.
 4. Control Cabinet: Steel, at least 14 gauge, 0.075 inch thick, with weather-tight seams and gaskets; thermally insulated to permit heater to maintain cabinet temperature to equipment operating minimum, flush access doors and panels, tamper proof hardware, master keyed locks, and concealed mounting bolts located inside of units.
 5. Configuration: As indicated on drawings.
 6. Operation Speed: 10 inches per second, nominal.

7. Barrier Gate Material: Vertical steel bars with smooth bottom edge free of protrusions and openings of 2-1/4 inch or less in size.
8. Barrier Gate Length: As indicated on drawings.
9. Barrier Gate Height: As indicated on drawings.
10. Fail-Safe Operation: Upon loss of primary electrical power, system automatically transfers to fail-safe mode allowing barrier gate to be manually pushed open without special knowledge, keys or releasing mechanisms.

2.06 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A Electrical Characteristics:
 1. Refer to Section 26 05 83 - Wiring Connections: Electrical connections.
- B Electrical Components: Self-contained, plug-in, and replaceable components that comply with NFPA 70 and are listed and labeled by UL (DIR) or ITS (DIR).
 1. Provide wiring for control units, zinc plated connection box, grounded convenience outlet, switch for automatic or manual operation, switch to disconnect power unit, thermostatically controlled with at least 250 watt heater strip, and thermally protected disconnect for motor.
- C Motor: NEMA MG 1 compliant.
- D Backup Power Inverter: Provides electrical power to allow system to remain in operation upon loss of primary electrical power.
- E Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized in compliance with NFPA 70.
- F Disconnect Switch: Factory mount disconnect switch in control panel.

2.07 VEHICLE DETECTION

- A Vehicle Detection: For use in temperature range of minus 40 to 160 degrees F; consisting of detection unit in conjunction with infrared scanner to activate parking revenue control device or access control device when vehicle enters or exits.
- B Sensing Loop: 14 gauge, 0.064 inch insulated wire; loop size of 48 by 72 inches, with loop extension cable and detector.
 1. Loop Groove Fill: Cold poured rubberized asphalt emulsion.
- C Infrared Scanner: Active infrared detectors mounted adjacent to vehicle entry and exit locations.

2.08 MATERIALS

- A Wood Species: Pine.
- B Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that anchor bolts are ready to receive this work and dimensions are as required by manufacturer.
- B Verify that electric connections are properly located and have necessary characteristics.

3.02 INSTALLATION

- A Install parking control system and components in accordance with manufacturer's instructions and in compliance with requirements.
- B Cut grooves in pavement surface, install vehicle detection loops and lead-in wires, and fill grooves with loop filler.
- C Install internal electrical wiring, conduit, junction boxes, transformers, circuit breakers, and auxiliary components as required.

3.03 ADJUSTING

- A Adjust system components for smooth operation.

3.04 MAINTENANCE

- A Provide service and maintenance of operating equipment for a period of two years from Date of Substantial Completion.

END OF SECTION 11 12 00

SECTION 12 21 13 - HORIZONTAL LOUVER BLINDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Horizontal slat louver blinds.
- B Operating hardware.

1.02 RELATED REQUIREMENTS

- A Section 06 10 00 - Rough Carpentry: Concealed wood blocking for attachment of headrail brackets.

1.03 REFERENCE STANDARDS

- A NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B WCMA A100.1 - Safety of Window Covering Products 2018.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordinate the placement of concealed blocking to support blinds. See Section 06 10 00.

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide data indicating physical and dimensional characteristics.
- C Shop Drawings: Indicate opening sizes, tolerances required, method of attachment, clearances, and operation.
- D Samples: Submit two samples, [____] inch long illustrating slat materials and finish, cord type and color.
- E Manufacturer's Installation Instructions: Indicate special procedures.
- F Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Blind Assemblies: One of each size.
 - 3. Extra Slats: 20 of each type and size.
 - 4. Extra Lift Cords, Control Cords, and Wands: One of each type.

1.06 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Horizontal Louver Blinds Without Side Guides:
 - 1. Hunter Douglas Architectural; CD Model: www.hunterdouglasarchitectural.com/#sle.
 - 2. MechoShade.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 BLINDS WITHOUT SIDE GUIDES

- A Description: Horizontal slat louvers hung from full-width headrail with full-width bottom rail.
- B Manual Operation: Control of raising and lowering by cord with full range locking; blade angle adjustable by control wand.
- C Metal Slats: Spring tempered pre-finished aluminum; square slat corners, with manufacturing burrs removed.
 - 1. Width: 1/2 inch.
 - 2. Thickness: 0.008 inch.
 - 3. Color: As selected by Architect.
- D Slat Support: Woven polypropylene cord, ladder configuration.

- E Head Rail: Pre-finished, formed aluminum box, with end caps; internally fitted with hardware, pulleys, and bearings for operation; same depth as width of slats.
 - 1. Height: [____] inches.
 - 2. Color: Same as slats.
- F Lift Cord: Braided nylon; continuous loop; complying with WCMA A100.1.
 - 1. Free end weighted.
 - 2. Color: As selected by Architect.
- G Control Wand: Extruded hollow plastic; hexagonal shape.
 - 1. Non-removable type.
 - 2. Length of window opening height less 3 inch.
 - 3. Color: As selected by Architect.
- H Headrail Attachment: Ceiling brackets.
- I Accessory Hardware: Type recommended by blind manufacturer.

2.03 FABRICATION

- A Determine sizes by field measurement.
- B Fabricate blinds to fit within openings with uniform edge clearance of [____] inch.
- C Fabricate blinds to cover window frames completely.
- D At openings requiring multiple blind units, provide separate blind assemblies with space of [____] inch between blinds, located at window mullion centers.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that openings are ready to receive the work.
- B Ensure structural blocking and supports are correctly placed. See Section 06 10 00.

3.02 INSTALLATION

- A Install blinds in accordance with manufacturer's instructions.
- B Secure in place with flush countersunk fasteners.
- C Place intermediate head supports at [____] inch on center.

3.03 TOLERANCES

- A Maximum Variation of Gap at Window Opening Perimeter: 1/4 inch.
- B Maximum Offset From Level: 1/8 inch.

3.04 ADJUSTING

- A Adjust blinds for smooth operation.

3.05 CLEANING

- A Clean blind surfaces just prior to occupancy.
- B See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 12 21 13

SECTION 12 36 00 - COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Countertops for architectural cabinet work.
- B Wall-hung counters and vanity tops.

1.02 RELATED REQUIREMENTS

- A Section 06 41 00 - Architectural Wood Casework.
- B Section 09 30 00 - Tiling: Tile for countertops.
- C Section 12 31 00 - Manufactured Metal Casework.
- D Section 22 40 00 - Plumbing Fixtures: Sinks.

1.03 REFERENCE STANDARDS

- A ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications 2022.
- B ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- C ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire 2019.
- D ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products 2018.
- E ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position 2022.
- F ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- G AWI (QCP) - Quality Certification Program Current Edition.
- H AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- I AWMAC (GIS) - Guarantee and Inspection Services Program Current Edition.
- J AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards 2021, with Errata.
- K IAPMO Z124 - Plastic Plumbing Fixtures 2017 (Reaffirmed 2021).
- L ISFA 2-01 - Classification and Standards for Solid Surfacing Material 2013.
- M NEMA LD 3 - High-Pressure Decorative Laminates 2005.
- N NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth 2019.
- O PS 1 - Structural Plywood 2009 (Revised 2019).
- P SEFA 2 - Installations 2010.
- Q TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation 2021.
- R WI (CCP) - Certified Compliance Program (CCP) Current Edition.
- S WI (MCP) - Monitored Compliance Program (MCP) Current Edition.

1.04 SUBMITTALS

- A See Section 01 30 00 - 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. Specimen warranty.
- C Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.

- D Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.
- E Sustainable Design Submittal: Documentation for sustainably harvested wood-based components.
- F Test Reports: Chemical resistance testing, showing compliance with specified requirements.
- G Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- H Installer's qualification statement.
- I Installation Instructions: Manufacturer's installation instructions and recommendations.
- J Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.05 QUALITY ASSURANCE

- A Fabricator Qualifications: Natural Stone Institute (NSI) Accredited Natural Stone Fabricator; www.naturalstoneinstitute.org/#sle.
- B Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.
- C Quality Certification:
 - 1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
 - 2. Comply with AWMAC (GIS) woodwork association quality certification service/program in accordance with requirements for work specified in this section.
 - 3. Comply with WI (CCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.woodworkinstitute.com/#sle.
 - 4. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 5. Provide designated labels on shop drawings as required by certification program.
 - 6. Provide designated labels on installed products as required by certification program.
 - 7. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A Store products in manufacturer's unopened packaging until ready for installation.
- B Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 COUNTERTOPS

- A Quality Standard: See Section 12 31 00.
- B Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.
 - 1. Laminate Sheet, Type [___]: NEMA LD 3, Grade HGS, 0.048 inch nominal thickness.
 - a. Manufacturers:
 - 1) Arborite; [_____]: www.arborite.com/#sle.
 - 2) Formica Corporation; [_____]: www.formica.com/#sle.
 - 3) Lamin-Art, Inc; [_____]: www.laminart.com/#sle.

- 4) Panolam Industries International, Inc; [____]: www.panolam.com/#sle.
- 5) Wilsonart; [____]: www.wilsonart.com/#sle.
- 6) Substitutions: See Section 01 60 00 - Product Requirements.
- b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
- c. Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
- d. Finish: Matte or suede, gloss rating of 5 to 20.
- e. Surface Color and Pattern: As indicated on drawings.
2. Exposed Edge Treatment: Square, substrate built up to minimum 1-1/4 inch thick; covered with matching laminate.
3. Back and End Splashes: Same material, same construction.
4. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Custom Grade.
- C Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
 1. Flat Sheet Thickness: 1/2 inch, minimum.
 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) Dupont; [____]: www.corian.com/#sle.
 - 2) Formica Corporation; [____]: www.formica.com/#sle.
 - 3) LG Hausys America, Inc; HI-MACS 12mm: www.lghausysusa.com/#sle.
 - 4) Wilsonart; [____]: www.wilsonart.com/#sle.
 - 5) Substitutions: See Section 01 60 00 - Product Requirements.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - d. Color and Pattern: As indicated on drawings.
 3. Other Components Thickness: 1/2 inch, minimum.
 4. Exposed Edge Treatment: Built up to minimum 1-1/2 inch thick; square edge; use marine edge at sinks.
 5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.
 6. Skirts: As indicated on drawings.
 7. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.

2.02 MATERIALS

- A Extruded Aluminum: ASTM B211/B211M, 6463 alloy, T5 temper.
- B Wood-Based Components:
 1. Wood fabricated from old growth timber is not permitted.
 2. Provide sustainably harvested wood, certified or labeled; see Section 01 60 00 - Product Requirements.

3. Wood fabricated from timber recovered from riverbeds or otherwise abandoned is permitted, unless otherwise noted, provided it is clean and free of contamination; identify source; provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc.
- C Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
- D Medium Density Fiberboard for Supporting Substrate: ANSI A208.2.
- E Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- F Cove Molding for Top of Splashes: Rubber with semi-gloss finish and T-spline to fit between splash and wall; 1/2 inch by 1/2 inch.
 1. Color: As selected by Architect from manufacturer's full line.
- G Joint Sealant: Mildew-resistant silicone sealant, white.

2.03 FABRICATION

- A Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 1. Join lengths of tops using best method recommended by manufacturer.
 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 2. Height: 4 inches, unless otherwise indicated.
- C Solid Surfacing: Fabricate tops and wall panels up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
- D Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

PART 3 EXECUTION

3.01 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.
- C Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- A Clean surfaces thoroughly prior to installation.
- B Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
- C Seal joint between back/end splashes and vertical surfaces.
 1. Where indicated use rubber cove molding.

2. Where applied cove molding is not indicated use specified sealant.

3.04 TOLERANCES

- A Variation From Horizontal: 1/8 inch in 10 feet, maximum.
- B Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
- C Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING

- A Clean countertops surfaces thoroughly.

3.06 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 12 36 00

SECTION 21 05 00 – COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Mechanical sleeve seals.
 - 3. Sleeves.
 - 4. Escutcheons.
 - 5. Fire-suppression equipment.
 - 6. Equipment installation requirements common to equipment sections.
 - 7. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Mechanical sleeve seals.
 - 2. Escutcheons.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MECHANICAL SLEEVE SEALS

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

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

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

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated and rough brass.
- E. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - e. Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - f. Piping in Equipment Rooms: One-piece, cast-brass type.
 - g. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- K. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.
- L. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- M. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Through-Penetration Firestop Systems" for materials.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

END OF SECTION 21 05 00

SECTION 21 10 00 – WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following fire-suppression piping inside the building:
 - 1. Wet-pipe sprinkler systems.
- B. Related Sections include the following:
 - 1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
 - 2. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps".
 - 3. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.3 SYSTEM DESCRIPTIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - c. General Storage Areas: Ordinary Hazard, Group 1.
 - d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - e. Office and Public Areas: Light Hazard.
 - f. Restaurant Service Areas: Ordinary Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
- C. The Contractor shall obtain water flow and pressure test information from the proper authorities and from a recent test of the existing main to which connection will be made. Test location shall be as close as possible to the intended point of connection.
- D. Tests shall be performed only by those agencies having such authority. Cost for testing will be at the expense of the Contractor. No extra payment for said testing will be allowed. Testing shall be performed prior to shop drawing submittal.

1.5 SUBMITTALS

- A. Product Data: For the following:
 1. Piping materials, including dielectric fittings and sprinkler specialty fittings.
 2. Pipe hangers and supports.
 3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
 4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
 5. Hose connections, including size, type, and finish.
 6. Hose stations, including size, type, and finish of hose connections; type and length of fire hoses; finish of fire hose couplings; type, material, and finish of nozzles; and finish of rack.
 7. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
 8. Alarm devices, including electrical data.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Fire-hydrant flow test report.
- D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- F. Welding certificates.

- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."

1.7 COORDINATION

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

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, 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 on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

- B. Grooved-End, Ductile-Iron Pipe: AWWA C151, with factory- or field-formed, radius-cut-grooved ends according to AWWA C606.
 - 1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Victaulic Co. of America.
 - b. Grooved-End Fittings: ASTM A 536, ductile-iron casting with OD matching ductile-iron-pipe OD.
 - c. Grooved-End-Pipe Couplings: AWWA C606, gasketed fitting matching ductile-iron-pipe OD. Include ductile-iron housing with keys matching ductile-iron-pipe and fitting grooves, prelubricated rubber gasket with center leg, and steel bolts and nuts.
 - d. Grooved-End-Pipe Transition Coupling: UL 213 and AWWA C606, gasketed fitting with end matching ductile-iron-pipe OD and end matching steel-pipe OD. Include ductile-iron housing with key matching ductile-iron-pipe groove and key matching steel-pipe groove, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.
 - 1. Cast-Iron Threaded Flanges: ASME B16.1.
 - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 - 3. Gray-Iron Threaded Fittings: ASME B16.4.
 - 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
 - 5. Steel Threaded Couplings: ASTM A 865.

- B. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut- or roll-grooved ends.
 - 1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Central Sprinkler Corp.
 - 3) Ductilic, Inc.

- 4) National Fittings, Inc.
 - 5) Star Pipe Products; Star Fittings Div.
 - 6) Victaulic Co. of America.
 - 7) Ward Manufacturing.
- b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- C. Threaded-End, Schedule 30 Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30; or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe; with factory- or field-threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
 5. Steel Threaded Couplings: ASTM A 865.
- D. Plain-End, Schedule 30 Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30; or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe.
1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Victaulic Co. of America.
 - 3) Ward Manufacturing.
- E. Grooved-End, Schedule 30 Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30; or ASTM A 795 and ASME B36.10M, Schedule 30 wrought-steel pipe; with factory- or field-formed, roll-grooved ends.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Central Sprinkler Corp.
 - 3) Ductilic, Inc.
 - 4) National Fittings, Inc.
 - 5) Star Pipe Products; Star Fittings Div.
 - 6) Victaulic Co. of America.
 - 7) Ward Manufacturing.

- b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- F. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.
- 1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Central Sprinkler Corp.
 - 3) Ductilic, Inc.
 - 4) National Fittings, Inc.
 - 5) Star Pipe Products; Star Fittings Div.
 - 6) Victaulic Co. of America.
 - 7) Ward Manufacturing.
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

2.4 DIELECTRIC FITTINGS

- A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.
- B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Hart Industries International, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Industries, Inc.; Wilkins Div.
- C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.
 - 1. Manufacturers:

- a. Capitol Manufacturing Co.
- b. Central Plastics Company.
- c. Epco Sales, Inc.
- d. Watts Industries, Inc.; Water Products Div.

2.5 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.
- B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
 1. Manufacturers:
 - a. Central Sprinkler Corp.
 - b. Fire-End and Croker Corp.
 - c. Viking Corp.
 - d. Victaulic Co. of America.
- C. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
 1. Manufacturers:
 - a. AGF Manufacturing Co.
 - b. Central Sprinkler Corp.
 - c. G/J Innovations, Inc.
 - d. Triple R Specialty of Ajax, Inc.

2.6 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.
- B. Ball Valves: Comply with UL 1091, except with ball instead of disc.
 1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 3. NPS 3: Ductile-iron body with grooved ends.
 4. Manufacturers:
 - a. NIBCO.
 - b. Victaulic Co. of America.
- C. Butterfly Valves: UL 1091.

1. NPS 2 and Smaller: Bronze body with threaded ends.
 - a. Manufacturers:
 - 1) Global Safety Products, Inc.
 - 2) Milwaukee Valve Company.
 2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
 - a. Manufacturers:
 - 1) Central Sprinkler Corp.
 - 2) Global Safety Products, Inc.
 - 3) McWane, Inc.; Kennedy Valve Div.
 - 4) Mueller Company.
 - 5) NIBCO.
 - 6) Pratt, Henry Company.
 - 7) Victaulic Co. of America.
- D. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Manufacturers:
 - a. AFAC Inc.
 - b. American Cast Iron Pipe Co.; Waterous Co.
 - c. Central Sprinkler Corp.
 - d. Clow Valve Co.
 - e. Crane Co.; Crane Valve Group; Crane Valves.
 - f. Crane Co.; Crane Valve Group; Jenkins Valves.
 - g. Firematic Sprinkler Devices, Inc.
 - h. Globe Fire Sprinkler Corporation.
 - i. Grinnell Fire Protection.
 - j. Hammond Valve.
 - k. Matco-Norca, Inc.
 - l. McWane, Inc.; Kennedy Valve Div.
 - m. Mueller Company.
 - n. NIBCO.
 - o. Potter-Roemer; Fire Protection Div.
 - p. Reliable Automatic Sprinkler Co., Inc.
 - q. Star Sprinkler Inc.
 - r. Stockham.
 - s. United Brass Works, Inc.
 - t. Venus Fire Protection, Ltd.
 - u. Victaulic Co. of America.
 - v. Watts Industries, Inc.; Water Products Div.
- E. Gate Valves: UL 262, OS&Y type.
1. NPS 2 and Smaller: Bronze body with threaded ends.

- a. Manufacturers:
 - 1) Crane Co.; Crane Valve Group; Crane Valves.
 - 2) Hammond Valve.
 - 3) NIBCO.
 - 4) United Brass Works, Inc.
2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

- a. Manufacturers:
 - 1) Clow Valve Co.
 - 2) Crane Co.; Crane Valve Group; Crane Valves.
 - 3) Crane Co.; Crane Valve Group; Jenkins Valves.
 - 4) Hammond Valve.
 - 5) Milwaukee Valve Company.
 - 6) Mueller Company.
 - 7) NIBCO.
 - 8) Red-White Valve Corp.
 - 9) United Brass Works, Inc.

2.7 SPECIALTY VALVES

- A. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.

1. Manufacturers:
 - a. AFAC Inc.
 - b. Grinnell Fire Protection.

2.8 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum pressure rating if sprinklers are components of high-pressure piping system.

- B. Manufacturers:
 1. AFAC Inc.
 2. Central Sprinkler Corp.
 3. Firematic Sprinkler Devices, Inc.
 4. Globe Fire Sprinkler Corporation.
 5. Grinnell Fire Protection.
 6. Reliable Automatic Sprinkler Co., Inc.
 7. Star Sprinkler Inc.
 8. Venus Fire Protection, Ltd.
 9. Victaulic Co. of America.
 10. Viking Corp.

- C. Automatic Sprinklers: With heat-responsive element complying with the following:

1. UL 1767, for early-suppression, fast-response applications.
- D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- E. Sprinkler types, features, and options as follows:
1. Extended-coverage sprinklers.
 2. Pendent sprinklers.
 3. Quick-response sprinklers.
 4. Recessed sprinklers, including escutcheon.
 5. Sidewall sprinklers.
 6. Upright sprinklers.
- F. Sprinkler Finishes: Chrome plated, bronze, and painted.
- G. 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, 2 piece, with 1-inch vertical adjustment.
 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- H. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.9 FIRE DEPARTMENT CONNECTIONS

- A. Manufacturers:
1. Elkhart Brass Mfg. Company, Inc.
 2. Fire-End & Croker Corporation.
 3. Guardian Fire Equipment, Inc.
 4. Kidde Fire Fighting.
 5. Potter Roemer.
 6. Reliable Automatic Sprinkler Co., Inc.
- B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets and escutcheon plate with marking similar to "AUTO SPKR and STANDPIPE."
1. Type: Flush with two inlets and square or rectangular escutcheon plate.
 2. Finish: Polished brass.
- C. Standard: UL 405.
- D. Connections: Two NPS 2-1/2 inlets and one NPS 4 outlet.
- E. Inlet Alignment: Inline, horizontal.

- F. Finish Including Sleeve: Polished bronze.
- G. Escutcheon Plate Marking: "AUTO SPKR."

2.10 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm: UL 464, with 6-inch- minimum-diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
 - 1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
- C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include 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.
 - 1. Manufacturers:
 - a. ADT Security Services, Inc.
 - b. Grinnell Fire Protection.
 - c. ITT McDonnell & Miller.
 - d. Potter Electric Signal Company.
 - e. System Sensor.
 - f. Viking Corp.
 - g. Watts Industries, Inc.; Water Products Div.
- D. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
 - 1. Manufacturers:
 - a. McWane, Inc.; Kennedy Valve Div.
 - b. Potter Electric Signal Company.
 - c. System Sensor.

2.11 PRESSURE GAGES

- A. Manufacturers:
 - 1. AGF Manufacturing Co.
 - 2. AMETEK, Inc.; U.S. Gauge.
 - 3. Brecco Corporation.

4. Dresser Equipment Group; Instrument Div.
 5. Marsh Bellofram.
 6. WIKA Instrument Corporation.
- B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.
1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING APPLICATIONS, GENERAL

- A. Shop weld pipe joints where welded piping is indicated.
- B. Do not use welded joints for galvanized-steel pipe.
- C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
 - 1. NPS 1-1/2 and Smaller: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 - 2. NPS 2: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 - 3. NPS 2: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 - 4. NPS 2-1/2 to NPS 6: Threaded-end, black, Schedule 30 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 - 5. NPS 2-1/2 to NPS 6: Grooved-end, black, Schedule 30 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 - 6. NPS 2-1/2 to NPS 6: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.6 VALVE APPLICATIONS

- A. Where specific valve types are not indicated, the following requirements apply:
 - 1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13.
 - a. Shutoff Duty: Use ball, butterfly, or gate valves.

3.7 JOINT CONSTRUCTION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
 - 1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
 - 2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
 - 3. Copper Tube: Roll-groove tubing. Use grooved-end fittings and grooved-end-tube couplings.
 - 4. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.
- D. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
 - 1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
 - 2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
 - 3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.8 WATER-SUPPLY CONNECTION

- A. Connect fire-suppression piping to building's interior water distribution piping. Refer to Division 22 Section "Domestic Water Piping" for interior piping.

3.9 PIPING INSTALLATION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install drain valves on standpipes.
- J. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- K. Install alarm devices in piping systems.
- L. Hangers and Supports: Comply with NFPA 13 for hanger materials.
 - 1. Install sprinkler system piping according to NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- N. Fill wet-pipe sprinkler system piping with water.

3.10 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty 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. Valves for Wall-Type Fire Hydrants: Install nonrising-stem gate valve in water-supply pipe.
- D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

3.11 SPRINKLER APPLICATIONS

- A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Recessed sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.
 - 5. Sprinkler Finishes:
 - a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
 - b. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

3.12 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valve at each check valve for fire department connection.

3.14 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

- C. Connect fire-suppression piping downstream of backflow preventer provided and installed by Contractor. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
- D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- F. Electrical Connections: Power wiring is specified in Division 26.
- G. Connect alarm devices to fire alarm.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.15 LABELING AND IDENTIFICATION

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

3.16 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Energize circuits to electrical equipment and devices.
 - 4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 5. Coordinate with fire alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire department equipment.
- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.17 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

3.18 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 21 10 00

SECTION 21 22 00 - CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Clean-agent fire-extinguishing systems.
 - 2. Pipe and fittings.
 - 3. Valves.
 - 4. Extinguishing-agent containers.
 - 5. Fire-extinguishing clean agent.
 - 6. Discharge nozzles.
 - 7. Manifold and orifice unions.
 - 8. Fire control panels.
 - 9. Detection devices.
 - 10. Manual stations.
 - 11. Switches.
 - 12. Alarm devices.

1.3 DEFINITIONS

- A. EPO: Emergency Power Off.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:
 - 1. [<Double click to insert sustainable design text for clean agents.>](#)
- C. Shop Drawings: Prepare in accordance with requirements of NFPA 2001, to include, but not be limited to, the following:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include design calculations.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, manufacturer-required clearances, method of field assembly, components, and location and size of each field connection.

4. Include diagrams for power, signal, and control wiring.
 5. Permit-Approved Documents: Working plans and hydraulic calculations approved by authorities having jurisdiction.
- D. Delegated-Design Submittal: For clean-agent fire-extinguishing systems indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Coordinate for enclosure integrity in accordance with NFPA 2001 requirements.
- B. Seismic Qualification Data: Certificates for extinguishing-agent containers and control panels, 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. Welding certificates.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For clean-agent fire-extinguishing system to include in emergency, operation, and maintenance manuals.

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. Deliver extra materials to Owner.
1. Nozzles: 2.

1.8 QUALITY ASSURANCE

- A. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Approvals' "Approval Guide."
- C. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."
- D. Seismic Performance: Fire-suppression piping shall withstand the effects of earthquake motions determined in accordance with NFPA 13 and 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 and the unit will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.5.

2.2 CLEAN-AGENT SYSTEMS

- 1. Ansul Inergen.
 - 2. Janus Fire Systems
 - 3. Pemall USA.
 - 4. Kidde Fire Systems.
- B. Source Limitations: Obtain clean-agent systems from single source from single manufacturer.
 - C. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity above the ceiling, below the ceiling, and below the raised floor. System includes separate zones above and below the ceiling and beneath the raised floor. If smoke is detected below the raised floor, extinguishing agent shall be discharged in the underfloor zone only. If smoke is detected below the ceiling, extinguishing agent shall be discharged in zones above and below the ceiling and below the floor. If smoke is detected above the ceiling, extinguishing agent shall be discharged in the zone above the ceiling only.
 - D. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.
 - E. Performance Requirements: Discharge IG-541 within 60 seconds and maintain 38 percent concentration by volume at 70 deg F for 10-minute holding time in hazard areas.
 - 1. IG-541 concentration in hazard areas greater than 40 percent immediately after discharge or less than 32 percent throughout holding time will not be accepted without written authorization from Owner and authorities having jurisdiction.
 - 2. System Capabilities: Minimum 2175-psig calculated working pressure upstream from orifice union, minimum 1000-psig calculated working pressure downstream from orifice union, and 2175-psig initial charging pressure.

- F. Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in another zone.
- G. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.
- H. System Operating Sequence:
 - 1. Actuating First Detector: Visual indication on annunciator panel. Energize audible and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire-alarm system.
 - 2. Actuating Second Detector: Visual indication on annunciator panel. Energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent. On agent discharge, release preaction valve to allow water to fill sprinkler system.
 - 3. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.
- I. System Operating Sequence: System shall be cross-zoned, air-sampling detectors and photoelectric detectors reporting to a fully programmable microprocessor-based control panel programmed to operate as follows:
 - 1. If one photoelectric detector and air-sampling detector reaches the third detection level (Fire 1), agent discharge will be initiated as described for the third detection level (Fire 1) below.
 - 2. Air-Sampling System:
 - a. First Detection Level (Alert): Mild audible and visual indication on annunciator panel. Strobe lights flash slowly in the protected area.
 - b. Second Detection Level (Action): Strong audible and visual indication on annunciator panel. Strobe lights flash rapidly in the protected area.
 - c. Third Detection Level (Fire 1): Strong audible and visual indication on annunciator panel. Energize horn(s), bell(s), and strobe light(s) in the protected area and outside entry doors. Shut down air-conditioning and ventilating systems serving the protected area, and close doors in the protected area. Send signal to fire-alarm system, initiate 30-second time delay for extinguishing-agent discharge, and discharge extinguishing agent. At agent discharge, terminate power to equipment in the protected area, and release preaction valve to allow water flow to sprinkler system.
 - d. Fourth Detection Level (Fire 2): Same as Fire 1.
- J. Manual stations shall immediately discharge extinguishing agent when activated.
- K. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release hand pressure on the switch to cause agent discharge after the time delay has expired.
- L. EPO: Will terminate power to protected equipment immediately on actuation.
- M. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.
- N. Power Transfer Switch: Transfer from normal to standby power source.

2.3 PIPE AND FITTINGS

- A. See "IG-541 Agent Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.
- C. Steel Pipe: ASTM A53/A53M, Type S, Grade B or ASTM A106/A106M, Grade A; Schedule 40, Schedule 80, and Schedule 160, seamless steel pipe.
 - 1. Threaded Fittings:
 - a. Malleable-Iron Fittings: ASME B16.3, Class 300.
 - b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
 - c. Fittings Working Pressure: 620 psig minimum.
 - d. Flanged Joints: Class 300 minimum.
 - 2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
 - 3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A47/A47M malleable iron or ASTM A536 ductile iron, with dimensions matching steel pipe and ends factory grooved in accordance with AWWA C606.
- D. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch-maximum thickness unless thickness or specific material is indicated.
- E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- F. 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.
- G. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

2.4 VALVES

- A. General Valve Requirements:
 - 1. UL listed or FM Approved for use in fire-protection systems.
 - 2. Compatible with type of clean agent used.
- B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.
- C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.
- D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.5 EXTINGUISHING-AGENT CONTAINERS

- A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
1. Finish: Red enamel or epoxy paint.
 2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
 3. Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.
 4. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

2.6 FIRE-EXTINGUISHING CLEAN AGENT

- A. IG-541 Clean Agent: Mixture of nitrogen, argon, and carbon dioxide inert gases.
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. Ansul Inergen.
 - b. Janus Fire Systems.
 - c. Pemall USA.
 - d. Kidde Fire Systems.
 2. Source Limitations: Obtain clean agents from single source from single manufacturer.

2.7 DISCHARGE NOZZLES

- A. Description: Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.
- B. Material: Corrosion-resistant metal.
- C. Stamped with orifice size and type.

2.8 MANIFOLD AND ORIFICE UNIONS

- A. Description: NRTL-listed device with minimum 2175-psig pressure rating, to control flow and reduce pressure of IG-541 gas in piping.
1. NPS 2 and Smaller: Piping assembly with orifice, sized for system design requirements.
 2. NPS 2-1/2 and Larger: Piping assembly with nipple, sized for system design requirements.

2.9 FIRE CONTROL PANELS

- A. Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
- B. Power Requirements: 120/240 V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.
- C. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
 - 1. Mounting: Surface.
- D. Supervised Circuits: Separate circuits for each independent hazard area.
 - 1. Detection circuits equal to required number of zones, or addressable devices assigned to required number of zones.
 - 2. Manual pull-station circuit.
 - 3. Alarm circuit.
 - 4. Release circuit.
 - 5. Abort circuit.
 - 6. EPO circuit.
- E. Control-Panel Features:
 - 1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
 - 2. Automatic switchover to standby power at loss of primary power.
 - 3. Storage container, low-pressure indicator.
 - 4. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.
- F. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless steel or aluminum enclosure.
- G. Standby Power: Sealed lead calcium batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

2.10 DETECTION DEVICES

- A. Description: Comply with NFPA 2001, NFPA 72, and UL 268; 24 V dc, nominal.
- B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
- C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

- D. Remote Air-Sampling Detector System: Includes air-sampling pipe network, laser-based photoelectric detector, sample transport fan, and control unit.
 - 1. Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
 - 2. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
 - 3. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05 inch wg at all sampling ports.
 - 4. Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.
- E. Signals to the Central Fire-Alarm Control Panel: Any type of local system trouble is reported to central fire-alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to central fire-alarm control panel as separately identified zones.

2.11 MANUAL STATIONS

- A. Description: Surface FM Approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.
- B. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
- C. Abort Switch: "ABORT" caption, momentary contact, with green finish.
- D. EPO Switch: "EPO" caption, with yellow finish.

2.12 SWITCHES

- A. Description: FM Approved or NRTL listed, where available, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.
 - 1. Low-Agent Pressure Switches: Pneumatic operation.
 - 2. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
 - 3. Door Closers: Magnetic retaining and release device or electrical interlock to cause door operator to drive the door closed.

2.13 ALARM DEVICES

- A. Description: FM Approved or NRTL listed, low voltage, and surface mounting. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" or Section 284621.13 "Conventional Fire-Alarm Systems" for alarm and monitoring devices.
- B. Bells: Minimum 6-inch diameter.
- C. Horns: 90 to 94 dBA.

- D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.
- E. Oxygen Deficiency Monitor.
 - 1. Sampling Method and Range: Diffusion, zero to 25 percent O₂.
 - 2. 24 V dc.
 - 3. Wall mounted with bracket.
 - 4. Built-in audible alarm 90 dBA.
 - 5. Backlit LCD.
 - 6. 10-year no-calibration sensor.
 - 7. No maintenance required.
 - 8. Signal Outputs: Standard 4- to 20-mA analog.
 - 9. Connections for system control data acquisition system and/or programmable logic controller.
 - 10. Plus or minus 1 percent accuracy of full scale.
 - 11. Operating temperature of minus 40 to plus 122 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with enclosure integrity requirements, installation tolerances, and other conditions affecting performance of the Work in accordance with NFPA 2001.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 IG-541 AGENT PIPING APPLICATIONS

- A. Piping between Storage Containers and Orifice Union: Schedule 80, steel pipe; forged-steel welding fittings; and welded joints.
- B. Piping Downstream from Orifice Union: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

3.3 CLEAN-AGENT SYSTEM INSTALLATION

- A. Install clean-agent containers, piping, and other components level and plumb, in accordance with manufacturers' written instructions.
- B. Clean-Agent Container Mounting:
 - 1. Install clean-agent containers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
 - 3. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

- C. Grooved Piping Joints: Groove pipe ends in accordance with AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant in accordance with manufacturer's written instructions.
- D. Install pipe and fittings, valves, and discharge nozzles in accordance with requirements listed in NFPA 2001, Section "Distribution."
 - 1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
 - 2. Support piping using supports and methods in accordance with NFPA 13.
 - 3. Install seismic restraints for extinguishing-agent piping systems.
 - 4. Install control panels, detection system components, alarms, and accessories, in accordance with requirements listed in NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

3.4 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
- E. Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in Section 284621.11 "Addressable Fire-Alarm Systems" or Section 284621.13 "Conventional Fire-Alarm Systems."

3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.7 IDENTIFICATION

- A. Identify system components and equipment. Comply with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment."

- B. Identify piping, extinguishing-agent containers, other equipment, and panels in accordance with NFPA 2001.
- C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.
- D. Install signs at entry doors to advise persons outside the room the meaning of horn(s), bell(s), and strobe light(s) outside the protected space.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
- D. Tests and Inspections:
 - 1. After installing clean-agent fire-extinguishing system and after electrical circuitry has been energized, test for compliance in accordance with requirements listed in NFPA 2001, Section "Approval of Installation."
 - 2. Clean-agent fire-extinguishing system and associated protected enclosure will be considered defective if either does not pass required tests and inspections.
 - 3. Prepare test and inspection reports in accordance with requirements listed in NFPA 2001, Section "Installation Acceptance."

3.9 CLEANING

- A. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

3.10 OPERATIONAL CONDITION SYSTEM FILLING

- A. Preparation:
 - 1. Verify that clean-agent fire-extinguishing system and protected enclosure have passed all required tests and inspections in accordance with NFPA 2001.
 - 2. Verify that clean-agent fire-extinguishing piping system installation is completed and cleaned.
 - 3. Verify complete enclosure integrity.
 - 4. Verify operation of ventilation and exhaust systems.
- B. Filling Procedures:
 - 1. Fill clean-agent fire-extinguishing containers with extinguishing agent, and pressurize to indicated charging pressure.
 - 2. Install filled containers.

3. Energize circuits.
4. Adjust operating controls.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

END OF SECTION 21 22 00

SECTION 21 31 13 – ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. In-line fire pumps.
 - 2. Fire-pump accessories and specialties.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Comply with NFPA 20.
- B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.
- 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.

2.2 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

- A. Description: Factory-assembled and -tested fire-pump and driver unit.
- B. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
- C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.3 IN-LINE FIRE PUMPS

A. Pump:

1. Standard: UL 448, for in-line pumps for fire service.
2. Casing: Radially split case, cast iron, with ASME B16.1 pipe-flange connections.
3. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
4. Wear Rings: Replaceable bronze.
5. Shaft and Sleeve: Steel shaft with bronze sleeve.
 - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
 - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
6. Mounting: Pump and driver shaft is vertical, with motor above pump and pump on base. Motor and pump rotating assembly shall be removable from top without removing the pump casing from the piping.

B. Coupling: None or rigid.

C. Driver:

1. Standard: UL 1004A.
2. Type: Electric motor; NEMA MG 1, polyphase Design B.

D. Capacities and Characteristics: See drawings.

2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Relief Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BERMAD Control Valves.
 - b. CLA-VAL.
 - c. Kunkle Valve.
 - d. OCV Control Valves.
 - e. WATTS.
2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

F. Discharge Cone: Closed or open type.

2.5 GROUT

- A. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- B. Equipment Mounting:
 - 1. Install fire pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
 - 3. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."
- C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
- D. Support piping and pumps separately, so weight of piping does not rest on pumps.
- E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 211313 "Wet-Pipe Sprinkler Systems."
- F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tapings. Comply with requirements for pressure gages specified in Section 211313 "Wet-Pipe Sprinkler Systems."
- G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
- H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
- I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.2 ALIGNMENT

- A. Align end-suction pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connections.
- D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.3 CONNECTIONS

- A. Comply with requirements for piping and valves specified in Section 211313 "Wet-Pipe Sprinkler Systems." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps and equipment to allow service and maintenance.
- C. Connect relief-valve discharge to drainage piping or point of discharge.
- D. Connect flowmeter-system meters, sensors, and valves to tubing.
- E. Connect fire pumps to their controllers.

3.4 IDENTIFICATION

- A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.5 FIELD QUALITY CONTROL

- A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Section 2623933 "Controllers for Fire-Pump Drivers."
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
 - 2. Test according to NFPA 20 for acceptance and performance testing.
 - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

- E. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.6 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 21 31 13

SECTION 22 05 00 – COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Sleeves.
 - 5. Equipment installation requirements common to equipment sections.
 - 6. Painting and finishing.
 - 7. Concrete bases.
 - 8. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.

2. Dielectric fittings.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.8 COMMISSIONING

- A. Contractor shall provide commissioning assistance to the owner's commissioning authority (CxA) at the time of substantial completion. The owner's CxA is responsible for developing the commissioning plan and functional performance testing checklist for the entire hot water heating system. The contractor shall make available during this functional performance testing:
 1. Contractor: 16 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.

- f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
- 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.6 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Braze Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

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

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 22 05 00

Section 22 05 13 – Common Motor Requirements for Plumbing Equipment

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.

- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 05 13

SECTION 22 05 19 – METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Thermometers.
- 2. Gages.
- 3. Test plugs.

- B. Related Sections:

- 1. Division 02 Section "Water Distribution" for domestic and fire-protection water service meters outside the building.
- 2. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
- 3. Division 22 Section "Facility Natural-Gas Piping" for gas meters.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED DIAL THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Marsh Bellofram.
 - 2. Tel-Tru Manufacturing Company.
 - 3. Trerice, H. O. Co.

4. Weiss Instruments, Inc.
 - B. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.
 - C. Case: Liquid-filled type, stainless steel with 5-inch diameter.
 - D. Element: Bimetal coil.
 - E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 - F. Pointer: Red metal.
 - G. Window: Glass or plastic.
 - H. Ring: Stainless steel.
 - I. Connector: Adjustable angle type.
 - J. Stem: Metal, for thermowell installation and of length to suit installation.
 - K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.

2.3 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AMETEK, Inc.; U.S. Gauge Div.
 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 3. Marsh Bellofram.
 4. Trelice, H. O. Co.
 5. Weiss Instruments, Inc.
 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
 1. Case: Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.
 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
 4. Movement: Mechanical, with link to pressure element and connection to pointer.
 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 6. Pointer: Red metal.
 7. Window: Glass.
 8. Ring: Metal.
 9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.

10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

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

1. Flow Design, Inc.
2. MG Piping Products Co.
3. Sisco Manufacturing Co.
4. Trerice, H. O. Co.
5. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for water service at 20 to 200 deg F shall be CR.

E. Test Kit: Furnish one test kit containing one pressure gage and adaptor, one thermometer, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Furnish and install thermometers at:

1. Inlet and outlet of water heater
2. Inlet and outlet of thermostatic mixing valves
3. In hot water storage tanks
4. Suction and discharge of each pump

- B. Provide the following temperature ranges for thermometers:
 - 1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
 - 2. Domestic Cold Water: 30 to 130 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

- A. Furnish and install gages at:
 - 1. Water service entrance
 - 2. Inlet and outlet at water heater
 - 3. Inlet and outlet of all RPZ's
 - 4. Suction and discharge of each pump
 - 5. Inlet and outlet of pressure regulators

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- D. Install needle-valve and snubber fitting in piping for each pressure gage.
- E. Install test plugs in tees in piping.
- F. Install connection fittings for attachment to portable indicators in accessible locations.
- G. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.
- H. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION 22 05 19

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

Lead-Free Statement: The wetted surfaces of plumbing fixtures described in this section have a weighted-average lead content of no more than 0.25% when used in applications intended to convey or dispense water for human consumption through drinking or cooking.

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. Bronze ball valves.
2. Bronze lift check valves.
3. Bronze swing check valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

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

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Lance Valves; a division of Advanced Thermal Systems, Inc.
 - e. Legend Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

2.3 BRONZE LIFT CHECK VALVES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - k. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:

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

- a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Zy-Tech Global Industries, Inc.
2. Description:
- a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. 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.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. 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.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball, butterfly valves.
 2. Throttling Service: Ball or butterfly valves.
 3. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
 - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 4. For Grooved-End Copper Tubing: Valve ends may be grooved.

END OF SECTION 22 05 23

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Pipe positioning systems.

4. Trapeze pipe hangers.
5. Metal framing systems. Include Product Data for components.
6. Pipe stands.
7. Equipment supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
1. AAA Technology & Specialties Co., Inc.
 2. Bergen-Power Pipe Supports.
 3. B-Line Systems, Inc.; a division of Cooper Industries.
 4. Carpenter & Paterson, Inc.
 5. Empire Industries, Inc.
 6. ERICO/Michigan Hanger Co.
 7. Globe Pipe Hanger Products, Inc.
 8. Grinnell Corp.
 9. GS Metals Corp.
 10. National Pipe Hanger Corporation.
 11. PHD Manufacturing, Inc.
 12. PHS Industries, Inc.
 13. Piping Technology & Products, Inc.
 14. Tolco Inc.
 15. Mifab Products.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

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

2.4 PIPE STAND FABRICATION

- A. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

- 1. Manufacturers:

- a. ERICO/Michigan Hanger Co.
- b. MIRO Industries.
- c. Mifab Products.

- B. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

- 1. Manufacturers:

- a. MIRO Industries.

2.5 EQUIPMENT SUPPORTS

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

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS ½ to NPS 30.
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS ½ to NPS 24, if little or no insulation is required.
 - 3. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS ½ to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS ¾ to NPS 8.
 - 5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS ½ to NPS 30.
 - 6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 7. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS ¾ to NPS 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS ¾ to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 - 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 4. C-Clamps (MSS Type 23): For structural shapes.
 - 5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

7. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

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

3.3 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 PAINTING

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

END OF SECTION 22 05 29

SECTION 22 05 53 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 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.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus 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), plus 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, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Red.

C. Background Color: White.

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

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

F. 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.

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

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

I. 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.
- 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. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 20 feet along each run.
- D. Pipe Label Color Schedule:
 - 1. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 - 2. Sanitary Waste and Storm Drainage Piping
 - a. Background Color: Safety black.
 - b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

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

END OF SECTION 22 05 53

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Domestic recirculating hot-water piping.
 - 4. Storm-water piping.
 - 5. Roof drains and rainwater leaders.
 - 6. Supplies and drains for handicap-accessible lavatories and sinks.
- B. Related Sections:
 - 1. Section 22 07 16 "Plumbing Equipment Insulation."

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000-Degree Pipe Insulation.
 - c. Manson Insulation Inc.; Alley-K.
 - d. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-(SSL). Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
 - d. Mon-Eco Industries, Inc.; 22-25.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

5. Color: White.

2.5 SEALANTS

A. Joint Sealants:

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

2.6 FIELD-APPLIED JACKETS

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

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

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Engineered Brass Company.
 - b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
 - c. McGuire Manufacturing.
 - d. Plumberex.
 - e. Truebro; a brand of IPS Corporation.
 - f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.

- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
- 3.5 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION
- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

3.6 FIELD-APPLIED JACKET INSTALLATION

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

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

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

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

- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold and Recirculated Hot Water: Insulation shall be the following:
 - 1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

- B. Domestic Hot Water ½" - 1-1/4": Insulation shall be the following:
 - 1. Mineral-Fiber, Preformed Pipe Insulation Type I: 1 inch thick.
- C. Domestic Hot Water ½" - 1-1/2" and larger: Insulation shall be the following:
 - 1. Mineral-Fiber, Preformed Pipe Insulation Type I: 1-1/2 inch thick.
- D. Stormwater and Overflow: Insulation shall be the following:
 - 1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- E. Roof Drain and Overflow Drain Bodies: Insulation shall be the following:
 - 1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Protective shielding pipe covers.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Exposed: Clarification - Intent for PVC jacket is to cover insulated pipe drops (and / or risers) which are exposed from floor to ceiling (approximately 10 feet above finished floor). Horizontal pipe runs exposed at structure in rooms without ceilings do not require PVC jacket.
 - 1. PVC: 20 mils thick.

END OF SECTION 22 07 00

SECTION 22 10 13 – FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.
 - 6. Grout.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

- A. Natural-Gas System Pressure within Buildings: See drawings.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated, stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
 - 5. Dielectric fittings.

6. Mechanical sleeve seals.
7. Escutcheons.

- B. Operation and Maintenance Data: For motorized gas valves, pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.8 COORDINATION

- A. The Utility Company will furnish and install a gas service complete with regulator and meter as shown on drawings. Utility Company's regulator will regulate from utility pressure down to 7 inches WC. Utility Company shall provide, in writing, certification of gas pressure before firing any appliances.
- B. Where systems are 1 psi or greater, provide Rockwell or Maxitrol over pressure protection relief valves.
- C. Owner will pay all charges accessed by Utility Company for gas service and meter installation.
- D. Connect to the gas service at meter outlet and furnish and install all pipe and fittings to all gas users.
- E. Coordinate sizes and locations of concrete bases with actual equipment provided.
- F. Provide concrete meter pad if required by utility company.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Corrugated stainless-steel tubing with polymer coating.
4. Operating-Pressure Rating: 0.5 psig.
5. End Fittings: Zinc-coated steel.
6. Threaded Ends: Comply with ASME B1.20.1.
7. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

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

- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig.
 - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Flowserve.
 - b. Homestead Valve; a division of Olson Technologies, Inc.
 - c. McDonald, A. Y. Mfg. Co.
 - d. Milliken Valve Company.
 - e. Mueller Co.; Gas Products Div.
 - f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.

3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

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

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Meter Company.
 - b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - c. Invensys.
 - d. Maxitrol Company.
 - e. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

2.6 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - f. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - d. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.7 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Escutcheons: With set screw.
 1. Finish: Polished chrome-plated or rough brass.
- D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
 1. Finish: Polished chrome-plated or rough brass.
- E. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
- F. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.10 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ASCO Power Technologies, LP; Division of Emerson.
 - b. Dungs, Karl, Inc.
 - c. Eclipse Combustion, Inc.
 - d. Goyen Valve Corp.; Tyco Environmental Systems.
 - e. Magnatrol Valve Corporation.
 - f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
 - g. Watts Regulator Co.; Division of Watts Technologies, Inc.
2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Confirm all gas piping rough-in dimensions for all equipment with the submittals of the equipment manufacturer before installing service.
- B. Install all gas piping in accordance with latest edition of NFPA Codes 54, 58 and 90A, including amendments thereto.
- C. Provide a main gas shut-off lubricated service cock with lock wing and lock wing sealing device at the building entrance and at meter.
- D. Exterior or underground gas piping shall be double-asphalt wrapped or pre-coated piping as approved. Depth of Bury shall be 36" minimum.
- E. Locate where shown, Fisher Governor Company, Rockwell or Maxitrol dead end lock-up type gas pressure regulator with internal relief valve, vent, rain and bug proof vent cap and a capacity of reducing from 2 psi down to 7 inches WC. Down stream gas pressure shall never exceed 7 inches WC.
- F. Comply with NFPA 54 for installation and purging of natural-gas piping.
- G. Install fittings for changes in direction and branch connections.
- H. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
- I. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- J. Install pressure gage downstream from each service regulator.
- K. Install manual shut off before each regulator.

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install escutcheons at penetrations of interior walls, ceilings, and floors.
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - d. Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - e. Piping in Equipment Rooms: One-piece, cast-brass type.
 - f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Through-Penetration Firestop Systems."
- M. Verify final equipment locations for roughing-in.
- N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

- R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints. Pipe vent containment conduit to island sink and terminate within chase in casework above floor.
1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 3. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- T. Connect branch piping from top or side of horizontal piping.
- U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- V. Do not use natural-gas piping as grounding electrode.
- W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- X. Install pressure gage upstream and downstream from each line regulator.

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. Install manual gas shutoff before electronic solenoid valves and regulators.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.

2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.7 HANGER AND SUPPORT INSTALLATION

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

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Install piping adjacent to appliances to allow service and maintenance of appliances.

B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment for piping and valve identification.

- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 OUTDOOR PIPING SCHEDULE

- A. Aboveground natural-gas piping shall be one of the following:
 - 1. NPS 2 and smaller; Steel pipe with malleable-iron fittings and threaded joints.
 - 2. NPS 2-1/2 and larger; Steel pipe with wrought-steel fittings and welded joints.

3.12 INDOOR PIPING SCHEDULE

- A. Aboveground piping NPS 2 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground piping NPS 2-1/2 and larger shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.
- C. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- D. Underground, below building, piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.
- E. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- F. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.13 MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

- B. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, nonlubricated or lubricated plug valve.

- C. Valves in branch piping for single appliance shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

END OF SECTION 22 10 13

SECTION 22 11 16 – DOMESTIC WATER PIPING

Lead-Free Statement: The wetted surfaces of plumbing fixtures described in this section have a weighted-average lead content of no more than 0.25% when used in applications intended to convey or dispense water for human consumption through drinking or cooking.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes domestic water piping inside the building.
- B. Water meters will be furnished by utility company for installation by Contractor.
- C. Related Sections include the following:
 - 1. Division 02 Section "Water Distribution" for water-service piping outside the building from source to the point where water-service piping enters the building.
 - 2. Division 22 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
 - 3. Division 22 Section "Plumbing Specialties" for water distribution piping specialties.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Water Samples: Specified in Part 3 "Cleaning" Article.
- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
 - a. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
- C. Copper Pressure-Seal-Joint Fittings
1. Manufacturers
 - a. Nibco Inc.

b. Viega

2. 2½" to 4": Cast bronze or wrought-copper fitting with EPDM.
3. Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
4. Pressure seal joints may be used for domestic water piping 2½" and larger in aboveground application.

2.4 VALVES

- A. Bronze and cast-iron, general-duty valves are specified in Division 22 Section "Valves."
- B. Balancing and drain valves are specified in Division 22 Section "Plumbing Specialties."

2.5 WATER METERS

- A. Remote Registration System: modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPE AND FITTING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.
- C. Grooved joints may be used on aboveground grooved-end piping.
- D. Under-Building-Slab, Water-Service Piping on Service Side of Water Meter: Refer to Division 2 Section "Water Distribution."
- E. Domestic Water Piping on Service Side of Water Meter inside the Building: Use the following piping materials for each size range:
 1. NPS 4 to NPS 6: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 2. NPS 4 to NPS 6: Hard copper tube, Type L with grooved ends; copper grooved-end fittings; grooved-end-tube couplings; and grooved joints.
- F. Under-Building-Slab, Domestic Water Piping on House Side of Water Meter, NPS 2-1/2 and Smaller: Soft or Hard copper tube, Type K; copper pressure fittings; and soldered joints.

- G. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
1. NPS 1 and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 2. NPS 1-1/4 and NPS 1-1/2: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 3. NPS 2: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 4. NPS 2-1/2 to NPS 3-1/2: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 5. NPS 4 to NPS 6: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 6. NPS 4 to NPS 6: Hard copper tube, Type L with grooved ends; copper grooved-end fittings; grooved-end-tube couplings; and grooved joints.

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use bronze ball valves for piping NPS 2 and smaller. Use butterfly or ball valves for piping NPS 2-1/2 and larger.
 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.
 3. Hot-Water-Piping, Balancing Duty: Calibrated or Memory-stop balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
1. Install hose-end drain valves at low points in water mains, risers, and branches.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Balancing valves are specified in Division 22 Section "Plumbing Specialties."

3.4 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."
- B. Install under-building-slab copper tubing according to CDA's "Copper Tube Handbook."
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Basic Mechanical Materials and Methods."

- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 22 Section "Meters and Gages," and drain valves and strainers are specified in Division 22 Section "Plumbing Specialties."
- E. Install water-pressure regulators downstream from shutoff valves. Water-pressure regulators are specified in Division 22 Section "Plumbing Specialties."
- F. Install domestic water piping level and plumb.

3.5 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- C. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- D. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

3.6 WATER METER INSTALLATION

- A. Rough-in domestic water piping and install water meter according to utility company's requirements.
- B. Install water meters according to AWWA M6 and utility's requirements.
 - 1. Install water meter with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
 - 2. Install remote registration system according to standards of utility and of authorities having jurisdiction.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 22 Section "Hangers and Supports." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:
 1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated.
 2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
 3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

- a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 4. Cap and subject piping to static water pressure of 1-1/2 times the operating pressure, (Min. 100psi) without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for one hour. Leaks and loss in test pressure constitute defects that must be repaired.
 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

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

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

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:
 1. Soft copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
 2. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
- E. Under-building-slab, fire-service-main piping, NPS6 to NPS 12, shall be one of the following:
 1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 2. Hard copper tube, ASTM B 88, Type L wrought-copper, solder-joint fittings; and soldered joints.
 3. Hard copper tube, ASTM B 88, Type L copper pressure-seal-joint fittings; and pressure-sealed joints.
 4. Hard copper tube, ASTM B 88, Type L; copper push-on-joint fittings; and push-on joints.
- G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 3. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
 4. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
- H. Aboveground, fire-service-main piping, NPS 6 to NPS 12, shall be the following:
1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

END OF SECTION 22 11 16

SECTION 22 11 19 – DOMESTIC WATER PIPING SPECIALTIES

Lead-Free Statement: The wetted surfaces of plumbing fixtures described in this section have a weighted-average lead content of no more than 0.25% when used in applications intended to convey or dispense water for human consumption through drinking or cooking.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated water mixing valves.
5. Strainers.
6. Outlet boxes.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water hammer arresters.

- B. Related Sections include the following:

1. Division 22 Section "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping" for water meters.

1.3 PERFORMANCE REQUIREMENTS

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

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze or Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Woodford Manufacturing Company.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome, nickel plated or Rough bronze.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.

- b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1020.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 5. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.3 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITT Industries; Bell & Gossett Div.
 - b. NIBCO INC.
 - c. Taco, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
2. Type: Ball valve with two readout ports and memory setting indicator.
3. Body: bronze,
4. Size: Same as connected piping, but not larger than NPS 2.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lawler Manufacturing Company, Inc.
 - b. Leonard Valve Company.
 - c. Powers; a Watts Industries Co.
 - d. Symmons Industries, Inc.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Exposed-mounting, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Tempered-Water Setting: 110 deg F and 140 deg F.
10. Valve Finish: Rough bronze.
11. Piping Finish: Copper.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Drain: Factory-installed, hose-end drain valve.

2.6 OUTLET BOXES

A. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. Plastic Oddities; a division of Diverse Corporate Technologies.
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.7 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS ½ or NPS ¾ threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.8 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. Mifab Products.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Watts Drainage Products Inc.
 - e. Woodford Manufacturing Company.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS ¾ or NPS 1.
7. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Nozzle and Wall-Plate Finish: Polished nickel bronze.
9. Operating Keys(s): One with each wall hydrant.

2.9 DRAIN VALVES

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

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

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

2.10 WATER HAMMER ARRESTERS

- A. Water Hammer Arresters: Note: Contractor shall provide and install access panel as required at all arrester locations.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. Mifab Products.
 - d. PPP Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products Inc.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASSE 1010 or PDI-WH 201.
 3. Type: Metal bellows or Copper tube with piston.
 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.

- C. Install balancing valves in locations where they can easily be adjusted.
- D. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install thermometers.
- E. Install water hammer arresters in water piping according to PDI-WH 201.

3.2 CONNECTIONS

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

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.4 ADJUSTING

- A. Set field-adjustable flow set points of balancing valves.
- B. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 11 19

SECTION 22 11 23 – DOMESTIC WATER PUMPS

Lead-Free Statement: The wetted surfaces of plumbing fixtures described in this section have a weighted-average lead content of no more than 0.25% when used in applications intended to convey or dispense water for human consumption through drinking or cooking.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. In-line, sealless centrifugal pumps.

1.3 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

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

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett Domestic Pump; ITT Corporation.
 - 3. Grundfos Pumps Corp.
 - 4. TACO Incorporated.
 - 5. WILO USA LLC - WILO Canada Inc.
- B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
- C. Pump Construction:
 - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
 - 2. Casing: Bronze, with threaded or companion-flange connections.
 - 3. Impeller: Plastic.
 - 4. Motor: Single speed, unless otherwise indicated.

2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.3 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
 - 1. Type: Water-immersion temperature sensor, for installation in piping.
 - 2. Enclosure: NEMA 250.
 - 3. Operation of Pump: On or off.

4. Transformer: Provide if required.
5. Power Requirement: 120 V, ac.
6. Settings:
 - a. HWCP-1; Start pump at 105 deg F and stop pump at 110 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PUMP INSTALLATION

- A. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.
- B. Install horizontally mounted, in-line, centrifugal pumps with shaft(s) horizontal.
- C. Install thermostats in hot-water return piping.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps to allow service and maintenance.
- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 1. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Division 22 Section "Domestic Water Piping Specialties."
- D. Comply with Division 26 Sections for electrical connections, and wiring methods.
- E. Connect thermostats to pumps that they control.

3.4 IDENTIFICATION

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

3.5 STARTUP SERVICE

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

3.6 ADJUSTING

- A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23

SECTION 22 12 23.11 – FACILITY INDOOR POTABLE-WATER STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel, precharged, potable-water storage tanks.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Source quality-control reports.
- C. Purging and disinfecting reports.

1.4 QUALITY ASSURANCE

- A. ASME Compliance for Steel Tanks: Fabricate and label steel, ASME-code, potable-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
- B. Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for potable-water storage tanks. Include appropriate NSF marking.

PART 2 - PRODUCTS

2.1 STEEL, PRECHARGED, POTABLE-WATER STORAGE TANKS

- A. Steel, Precharged, Bladder, Water Storage Tanks:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Flexcon Industries.
 - d. Flo Fab Inc.
 - e. Myers, F.E.; Pentair Ltd.
 - f. State Industries.
 - g. TACO Comfort Solutions, Inc.

- h. Wessels Company.
 - 2. Description: Steel, vertical, pressured-rated tank with cylindrical sidewalls and with air-charging valve and air precharge.
 - 3. Operation: Factory-installed, butyl-rubber bladder.
- B. Construction: ASME code, steel, constructed with nontoxic welded joints, for 125-psig working pressure.
- C. Tappings: Factory-fabricated stainless steel, welded to tank before testing and labeling.
 - 1. NPS 2 and Smaller: ASME B1.20.1, with female thread.
 - 2. NPS 2-1/2 and Larger: ASME B16.5, flanged.
- D. Specialties and Accessories: Include tappings in tank and the following:
 - 1. Pressure gage.
- E. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank before testing and labeling.
- F. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.
 - 1. Coating: Epoxy resin.
- G. Exterior Coating: Manufacturer's standard enamel paint.

2.2 SOURCE QUALITY CONTROL

- A. Test and inspect potable-water storage tanks according to the following tests and inspections and prepare test reports:
 - 1. Pressure Testing for ASME-Code, Potable-Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks. Fill tanks with water, vent air, pressurize to 1-1/2 times tank pressure rating, disconnect test equipment, hold pressure for 30 minutes with no drop in pressure, and check for leaks.
- B. Repair or replace tanks that fail test with new tanks, and repeat until test is satisfactory.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.
- B. Anchor tank supports and tanks to substrate.

- C. Install thermometers and pressure gages on water storage tanks and piping if indicated. Thermometers and pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."
- D. Install the following devices on tanks where indicated:
 - 1. Temperature and pressure relief valves.
 - 2. Vacuum relief valves.
 - 3. Connections to accessories.
- E. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to potable-water storage tanks to allow service and maintenance.
- C. Connect water piping to water storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.
 - 1. General-duty valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
 - a. Valves NPS 2 and Smaller: Gate or ball.
 - b. Valves NPS 2-1/2 and Larger: Gate or butterfly.
 - c. Drain Valves: NPS 3/4 gate or ball valve. Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.
 - 2. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Section 221116 "Domestic Water Piping."

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following final checks before filling:
 - 1. Verify that air precharge in precharged tanks is correct.
 - 2. Test operation of tank accessories and devices.
 - 3. Verify that pressure relief valves have correct setting.
 - a. Manually operate pressure relief valves.
 - b. Adjust pressure settings.

4. Verify that vacuum relief valves are correct size.
 - a. Manually operate vacuum relief valves.
 - b. Adjust vacuum settings.
- B. Filling Procedures: Follow manufacturer's written procedures. Fill tanks with water to operating level.

3.5 CLEANING

- A. Clean and disinfect potable-water storage tanks.
- B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in AWWA C652 or as described below:
 1. Purge water storage tanks with potable water.
 2. Disinfect tanks by one of the following methods:
 - a. Fill tanks with water-chlorine solution containing at least 50 ppm of chlorine. Isolate tanks and allow to stand for 24 hours.
 - b. Fill tanks with water-chlorine solution containing at least 200 ppm of chlorine. Isolate tanks and allow to stand for three hours.
 3. Flush tanks, after required standing time, with clean, potable water until chlorine is not present in water coming from tank.
 4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination made by authorities having jurisdiction shows evidence of contamination.
- C. Prepare written reports for purging and disinfecting activities.

END OF SECTION 22 12 23.11

SECTION 22 13 16 – SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 PVC PIPE AND FITTINGS

- A. Solid-Wall Schedule 40 PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Schedule 40 CPVC Pipe: ASTM 2846 with DWV fittings.
- D. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Aboveground, soil and waste piping shall be any of the following:
 - 1. Schedule 40 PVC pipe, PVC socket fittings and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- B. Aboveground, vent piping shall be same material as soil and waste piping.
- C. Underground, soil, waste, and vent piping shall be any of the following:
 - 1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints for grease waste piping to grease interceptor.
 - 2. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
 - 3. Schedule 40 PVC pipe, PVC socket fittings and solvent-cemented joints.
- D. All soil, waste and vent piping above ceilings to be wrapped in fiberglass insulation.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Basic Mechanical Materials and Methods."
- D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- I. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Basic Mechanical Materials and Methods."
- B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

- D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- E. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 5. NPS 6: 10 feet with 5/8-inch rod.
 - 6. NPS 8: 10 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve and union for each connection.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch

wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 1. Solid-wall PVC pipe, PVC socket fittings and solvent-cemented joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
 1. Solid-wall PVC pipe, PVC socket fittings and solvent-cemented joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 1. Solid-wall PVC pipe, PVC socket fittings and solvent-cemented joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
 1. Service class, cast-iron pipe and fittings; gaskets; and gasketed joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- F. Underground, soil, waste and vent piping NPS4 and smaller shall be any of the following:
 1. Solid wall PVC pipe, PVC socket fittings and solvent-cemented joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
 1. Solid wall PVC pipe, PVC socket fittings and solvent-cemented joints.
 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

- H. Underground, soil and waste piping designated as grease waste shall be the following:
 - 1. Schedule 40 CPVC, pipe with DWV fittings.

END OF SECTION 22 13 16

SECTION 22 13 19 – SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Grease interceptors.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Grease interceptors.
 - 2. Cleanouts.
 - 3. Floor drains.
- B. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.
- C. Coordinate sloping of finished floors to floor drains, floor sinks and trench drains.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Mifab Products.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for adjustable housing or cast-iron soil pipe with cast-iron ferrule cleanout.
3. Size: Same as connected branch.

B. Cast-Iron Wall Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Mifab Products.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: as required to match connected piping.
5. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Mifab Products.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.

2.3 GREASE INTERCEPTORS

- A. Grease Interceptors: Precast concrete complying with ASTM C 913.
 1. Include rubber-gasketed joints, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
 2. Structural Design Loads:
 - a. Heavy-Traffic Load: Comply with ASTM C 890, A-16.
 3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.
 4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
 5. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover.
 - a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
 - b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
- B. Capacities and Characteristics:
 1. Retention Capacity: 1000 gallons.
 2. Inlet and Outlet Pipe Size: 4 NPS.
 3. Installation Position: Underground with manhole riser to grade.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Assemble open drain fittings and install with top of hub 2 inches above floor.
- G. Install deep-seal traps on floor drains.
- H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- J. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
- K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

SECTION 22 14 13 – FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following storm drainage piping inside the building.
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

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

1.3 SUBMITTALS

- A. Roof drains.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials and joining methods for specific services, service locations and pipe sizes.
- B. PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns.
 - 2. Solvent Cement and Adhesive Primer:
 - a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 ROOF DRAINS

- A. As scheduled on drawings.

2.3 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

- A. Conductor Nozzles
 1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
 2. Size: Same as connected conductor.
- B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Aboveground storm drainage piping shall be the following:
 1. PVC pipe, PVC socket fittings and solvent-cemented joints.
- C. Aboveground horizontal storm and overflow piping shall be insulated, as well as roof drain bodies, per Division 22 "Plumbing Insulation".
- D. Underground storm drainage piping shall be the following:
 1. PVC pipe, PVC socket fittings and solvent-cemented joints.

3.2 PIPING INSTALLATION

- A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Insulate roof drain bodies, overflows and horizontal piping as specified in Division 22 Section "Plumbing Insulation".
- D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22.

- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Install wall-penetration-fitting system at each service pipe penetration through foundation wall. Make installation watertight.
- G. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- H. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- I. Install underground PVC storm drainage piping according to ASTM D 2321.
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- D. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.

- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

3.5 CONNECTIONS

- A. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect storm drainage piping to roof drains and storm drainage specialties.

3.6 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction.

3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 14 13

SECTION 22 34 00 - FUEL-FIRED, DOMESTIC-WATER HEATERS

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. Commercial, closed-combustion, gas-fired, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 PERFORMANCE REQUIREMENTS

- A. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Product certificates.
- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- E. Operation and maintenance data.
- F. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

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

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.6 COORDINATION

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

1.7 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

- A. Commercial, Closed-Combustion, Gas-Fired, Storage, Domestic-Water Heaters:
1. Standard: ANSI Z21.10.3/CSA 4.3.
 2. Storage-Tank Construction: ASME-code steel with 150-psig working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner: For use with atmospheric, gas-fired, domestic-water heaters and natural-gas fuel.

- g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
- h. Temperature Control: Adjustable thermostat.
- i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
- j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

B. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradford White.
 - b. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - c. State Industries.
2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions.
4. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
5. Factory-Installed Storage-Tank Appurtenances:
 - a. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - b. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - c. Jacket: Steel with enameled finish.
 - d. Burner: High efficiency pre-mix powered burner.
 - e. Control: Electronic operating thermostat with LED temperature readout.
 - f. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - g. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
6. Direct Vent: (3") 4" diameter PVC pipe.
7. Sealed Combustion: 4" diameter PVC pipe.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Compression Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL Inc.
 - b. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - c. State Industries.
 - d. Wilkins.
 2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Heat-Trap Fittings: ASHRAE 90.2.
- D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
- E. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- F. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
- G. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
- H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
- I. Where water heater is located at an elevation above the fixture outlets or is bottom fed, provide and install a vacuum relief valve.
1. Wilkins VR10
 2. Watts N36
 3. Conbraco 37-100
 4. Cash-Acme VR-81

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03 Section "Concrete and Masonry".
1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 2. Maintain manufacturer's recommended clearances.
 3. Arrange units so controls and devices that require servicing are accessible.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 8. Anchor domestic-water heaters to substrate.
- B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- C. Install gas-fired, domestic-water heaters according to NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Division 23 Section "Facility Natural-Gas Piping."
- D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

- F. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."
- H. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- I. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- J. Fill domestic-water heaters with water.

3.2 CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Division 22 Section "Domestic Water Piping."
- B. Comply with requirements for gas piping specified in Division 23 Section "Facility Natural-Gas Piping."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 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.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION 22 34 00

SECTION 22 40 00 – PLUMBING FIXTURES

Lead-Free Statement: The wetted surfaces of plumbing fixtures described in this section have a weighted-average lead content of no more than 0.25% when used in applications intended to convey or dispense water for human consumption through drinking or cooking.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets.
 - 2. Flushometers.
 - 3. Toilet seats.
 - 4. Protective shielding guards.
 - 5. Fixture supports.
 - 6. Water closets.
 - 7. Urinals.
 - 8. Lavatories.
 - 9. Stainless steel sinks.
 - 10. Electric water coolers.
- B. Related Sections include the following:
 - 1. Division 2 Section "Water Distribution" for exterior plumbing fixtures and hydrants.
 - 2. Division 10 Section "Toilet and Bath Accessories."
 - 3. Division 22 Section "Plumbing Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- F. FRP: Fiberglass-reinforced plastic.
- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

- F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
- G. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- H. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

PART 2 - PRODUCTS

2.1 FAUCETS

A. Lavatory/Sink Faucets:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation.
 - b. Chicago Faucets.
 - c. Delta Faucet Company.
 - d. Elkay Manufacturing Co.
 - e. T & S.
 - f. Kohler Co.
 - g. Zurn Plumbing Products Group; Commercial Brass Operation.
- 2. Description: Refer to Plumbing Fixture Schedule on drawings.

B. Shower Faucets:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets.
 - b. Delta Faucet Company.
 - c. Leonard Valve Company.
 - d. Powers; a Watts Industries Co.
 - e. Speakman Company.
 - f. Symmons Industries, Inc.
 - g. T & S Brass and Bronze Works, Inc.
 - h. Zurn Plumbing Products Group; AquaSpec Commercial Faucet Operation.
- 2. Description: Refer to Plumbing Fixture Schedule on drawings. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.

2.2 FLUSHOMETERS

A. Flushometers:

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

- a. Delta Faucet Company.
 - b. Sloan Valve Company.
 - c. Zurn Plumbing Products Group; Commercial Brass Operation.
2. Description: Refer to Plumbing Fixture Schedule on drawings. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

2.3 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bemis Manufacturing Company.
 - b. Church Seats.
 - c. Olsonite Corp.
 - d. Sanderson Plumbing Products, Inc.; Beneke Div.
2. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, solid plastic with antimicrobial agent.
 - b. Configuration: Open front without cover.
 - c. Size: Elongated.
 - d. Hinge Type: SS, self-sustaining.
 - e. Color: White.

2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
 - b. McGuire Manufacturing Co., Inc.
 - c. Plumberex Specialty Products Inc.
 - d. TCI Products.
 - e. TRUEBRO, Inc.
 - f. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.5 FIXTURE SUPPORTS

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

1. Josam Company.
2. Mifab Products.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water-Closet Supports:

1. Description: Combination carrier designed for mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:

1. Description: Type II, urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

E. Sink Supports:

1. Description: Type II, sink carrier with hanger plate, bearing studs, and tie rod for sink-type fixture. Include steel uprights with feet.

2.6 WATER CLOSETS

A. Water Closets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Eljer.
 - d. Kohler Co.
 - e. Zurn
2. Description; Refer to Plumbing Fixture Schedule on drawings.

2.7 URINALS

A. Urinals:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Eljer.
 - d. Kohler Co.
 - e. Zurn
2. Description: Refer to Plumbing Fixture Schedule on drawings.

2.8 LAVATORIES

A. Lavatories:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Kohler Co.
 - d. Zurn
2. Description: Refer to Plumbing Fixture Schedule on drawings.

2.9 STAINLESS STEEL SINKS

A. Commercial Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Tabco.
 - b. Elkay Manufacturing Co.
 - c. Just Manufacturing Company.
 - d. Metal Masters Foodservice Equipment Co., Inc.
2. Description: Refer to Plumbing Fixture Schedule on drawings.

2.10 WATER COOLERS

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

1. Elkay Manufacturing Co.
2. Halsey Taylor.
3. Haws Corporation.

B. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult-mounting height.

- a. Cabinet: Bilevel with two attached cabinets, vinyl-covered steel with stainless-steel top.
- b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
- c. Control: Push bar.
- d. Supply: NPS 3/8 with ball, gate, or globe valve.
- e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
- f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
- g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - 1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
 - 2) Electrical Characteristics: 120-V ac; single phase; 60 Hz.
- h. Support: Type II, bilevel, hanger-type carrier with three vertical uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

- G. Install counter-mounting fixtures in and attached to casework.
- H. Install fixtures level and plumb according to roughing-in drawings.
- I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "Valves."
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- M. Install toilet seats on water closets.
- N. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- O. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- P. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- Q. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Basic Mechanical Materials and Methods."
- R. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant.
- S. Provide air chambers full size of pipe, but not less than 3/4" and not less than 12" long in all hot and cold water piping at each fixture.
 - 1. Provide 1-1/4" x 18" long air chamber at each flush valve water closet.
 - 2. Water hammer arrestors may be used in lieu of air chambers.

3.3 CONNECTIONS

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

- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

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

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.
- D. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

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

END OF SECTION 22 40 00

SECTION 23 05 00 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Concrete bases.
 - 11. Supports and anchorages.

1.3 DEFINITIONS

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

1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-dieneterpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.8 HAZARDOUS MATERIALS

- A. No asbestos-containing materials may be used anywhere on this project.
- B. No lead-based materials may be used anywhere on this project.

1.9 LOCATION OF EQUIPMENT

- A. The approximate location of all equipment and pipe is shown on the drawings.
- B. Architect / Engineer may change the location of any equipment or piping 5' in any direction without these changes being made the subject of an extra charge provided such changes are made before final installation.
- C. Where offsets in piping, additional fittings, necessary drains, minor valves, traps, devices, etc., are required to complete the installation, to clear obstructions or the work of other Contractors or for the proper operation of the system, these shall be deemed to be included in the Contract and shall be furnished and installed complete by the Contractor at no additional charge.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

- a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
 - D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
 - E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
 - F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
 - G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 - H. Solvent Cements for Joining Plastic Piping:
 1. CPVC Piping: ASTM F 493.
 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.
- ### 2.3 TRANSITION FITTINGS
- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- ### 2.4 DIELECTRIC FITTINGS
- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
 - B. Insulating Material: Suitable for system fluid, pressure, and temperature.
 - C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.

- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.

- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.

- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.

- d. Victaulic Co. of America.

2.5 MECHANICAL SLEEVE SEALS

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

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 1. Finish: Polished chrome-plated and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated and rough brass.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.

- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 2. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - 3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - 5. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - 6. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - 7. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - 8. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Through-Penetration Firestop Systems" for materials.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.3 PIPING CONNECTIONS

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

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

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

3.5 SPACE PREFERENCE

- A. Coordinate the location and elevation of all work. Verify with all other Contractors to avoid conflicts.
- B. In case of conflicts, the following installation priorities shall prevail:
 - 1. Recessed electric fixtures
 - 2. Sanitary / vent and storm drainage
 - 3. Closed loop water piping
 - 4. Low pressure ductwork
 - 5. Domestic water lines
 - 6. Sprinkler lines
 - 7. Electric conduits
- C. No other work shall have preference over plumbing lines below fixtures.
- D. No other work shall have preference over bus duct or conduit above or below electric switchgear and panels.
- E. No piping conveying fluids shall be installed directly over electrical or elevator equipment.

3.6 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

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

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.9 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 23 05 00

SECTION 23 05 10 – HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Contractor: Provide and install heating, ventilating and air conditioning systems as shown on the drawings and as specified herein. Work includes but is not limited to the following:
 - a. Demolition
 - b. Hot water piping
 - c. Chilled water piping
 - d. Vent piping
 - e. Drain piping
 - f. Water specialties
 - g. Expansion tanks
 - h. Expansion joints
 - i. Valves and fittings
 - j. Refrigerant piping and accessories
 - k. Circulating pumps
 - l. Water treatment
 - m. Flex connections
 - n. Testing
 - o. Cleaning
 - r. Condensate pumps

B. Work Not Included

1. Materials, equipment or final connections to items of equipment specified or noted on the drawings to be furnished or executed under another contract.

1.2 RELATED WORK

A. Specified elsewhere:

1. Sections: Architectural / Structural and General Work
2. Section 22 00 20 - Mechanical Insulation
3. Division 23 - Mechanical Systems

1.3 QUALITY ASSURANCE

- A. Use only new material and apparatus of the specified design and manufacturer. Furnish all materials in accordance with latest ANSI, AWWA, ASTM, NFPA, AGA, ASME, IBR, UL standards and other applicable standards or codes.

1.4 SUBMITTALS

- A. See Architectural Sections for requirements.

PART 2 - PRODUCTS

2.1 PIPING DATA - HEATING

- A. Install all vents for all of the safety valves, pressure reducing valves and all equipment in this contract requiring such vents. Connect safety valves to vent lines with an open connection made by sliding a larger pipe over the stub from exhaust valve. Unless otherwise shown on the drawings, extend vents through roof and where possible pitch all vent piping to drain into a condensate receiver. Flash all vents through roof with a 12" high roof jack fabricated of 6 lb sheet lead and extend 12" from side of vent in all directions on roof. Provide counter-flashing rain skirt clamped around pipe over top of roof jack.
- B. Pipe and fittings for the various systems shall be as follows:
- C. Hot Water Piping
1. All hot water piping shall be standard weight Schedule 40 black steel pipe with all joints 2½" and larger welded or flanged. Fittings shall be standard weight screwed cast iron or butt-type welding. Accomplish all reductions in horizontal supply pipe size with eccentric reducing fittings installed with top level.
 2. At Contractor's option, type L hard drawn copper tubing with wrought copper fittings may be used in sizes 2-1/2" and smaller. Solder all joints with 95-5 tin-antimony solder. Use dielectric unions at all connections to dissimilar materials.
- D. Chilled Water Piping
1. All chilled water piping shall be standard weight Schedule 40 black steel pipe with all joints 2½" and larger welded or flanged. Fittings shall be standard weight screwed cast iron or butt-type welding. Accomplish all reductions in horizontal supply pipe size with eccentric reducing fittings installed with top level.
 2. At Contractor's option type L hard drawn copper tubing with wrought copper fittings may be used in sizes 2" and smaller. Solder all joints with 95-5 tin-antimony solder. Use dielectric unions at all connections to dissimilar materials.
- E. Vent Piping
1. All vent piping shall be Schedule 40 black steel, with all joints welded. Fittings shall be standard weight butt-type welding of same material as piping.
- F. Drain Piping
1. All above grade condensate drain piping shall be schedule 40 black steel or type DWV copper piping with copper drainage fittings. Minimum size shall be 1½". Provide cleanout plug at all points where piping changes direction.
- G. Make-Up Water
1. All final connections of make-up water from the domestic water system shall be of materials as specified in the Plumbing Section - 22 10 10 of these Specifications. Final connections shall be by Contractor.

2.2 HOT WATER SPECIALTIES

- A. Manual air vents in pipelines shall be constructed of short vertical sections of line size piping to form air chamber. See detail on drawings. Provide vents in all high points in piping and at the top of each pipe riser.
- B. Manual air vents at fin tube heating elements, cabinet unit heaters shall be brass needle valves, screwdriver operated (Dole No. 9).
- C. Automatic air vents shall be chrome-plated brass, float type, suitable for maximum system pressure.
- D. Acceptable Manufacturers
 - 1. Dunham-Bush
 - 2. Dole
 - 3. Sarco

2.3 PIPING SPECIALTIES

- A. Provide and install pressure/temperature measuring glands to allow pressure and temperature readings to be taken. Units shall be suitable for 500 psig with temperatures ranging from 40 to 275°F. Units shall utilize nordel seals. (Minister and Associates, 314 New Salem Street, Park Forest, Illinois 60466 (708) 481-6090). Sisco P/T plugs: MESA Inc. (314) 644-6060. Test Plugs: H.O. Trerice Co. TU: HCI 800-313-4822.
- B. Provide at the following locations:
 - 1. Reheat coils (including in VAV boxes)
 - 2. Fan coils and blower coils
 - 3. Chilled water coils
 - 4. Hot water heating coils

2.4 DIAPHRAGM-TYPE EXPANSION TANKS

- A. Provide and install ASME-stamped expansion tanks suitable for 125 psig working pressure and 240°F operating temperature in HW and CHW systems. Tank shall be primed steel with heavy duty butyl replaceable bladder. Tank shall be furnished with mounting saddles, system tapping and charging valve.
- B. Contractor shall note mounting position of tanks and order tanks to suit.
- C. Tank shall be air precharged to the initial fill pressure of the system.
- D. Mount vertical tanks on 3-1/2" poured concrete housekeeping pad. Pad by Contractor.
- E. Pipe tanks per manufacturer's written recommendations. Note need for anti-siphon loops in heating application.
- F. Acceptable Manufacturers

1. Amtrol
2. Thrush
3. Taco
4. Armstrong
5. B&G

G. Forward shop drawing submittals to Architect / Engineer for review.

2.5 AIR SEPARATOR

A. Provide a line-size centrifugal air separator in the hot water and chilled water systems to provide for removal of air. The unit shall be designed to separate the water and air by centrifugal force and shall have flanged inlet and outlet connections and a top center tapping for the air eliminator connection to the expansion tanks.

B. Acceptable Manufacturers

1. Bell & Gossett
2. Taco
3. Thrush or Armstrong

C. Forward shop drawing submittals to the Architect / Engineer for review.

2.6 WATER PRESSURE REDUCING VALVE

A. Provide a pressure reducing valve on the cold water make up line to the hot water heating (and chilled water) system. Outlet pressure shall be adjustable and shall be set at 15 psi. The valve shall control the pressure on the heating and chilled water systems, shall be preceded by a gate valve, and shall have a pressure gauge installed after it.

B. Acceptable Manufacturers

1. Bell and Gossett
2. Taco
3. Thrush
4. Armstrong

2.7 VALVES - HEATING

A. Use valves for all piping systems as scheduled below and locate in main and branch lines and at equipment where shown on the drawings for operation and maintenance of the system.

B. All valves shall be line-sized (same size as line in which they are installed). Exceptions to this requirement may be made for:

1. Control valves.
2. Balancing valves.
3. Triple duty valves.

C. Install a screwed or flanged union between each valve, within 6" of the valve and any equipment or apparatus which may require service or removal. Arrange piping and valves in such a manner

that no piping need be disturbed, except branch to individual equipment or apparatus, when removing or servicing.

- D. All valves shall be tight in operation and if any leaks are found, they shall be repacked with best grade of packing to suit service.
- E. All risers shall be valved. Branch runouts shall be valved where indicated on the drawings.
- F. All bypass valves shall be globe or butterfly type.
- G. All shut-off valves 3" and larger shall be either gate valves or butterfly valves.
- H. Gate Valves

1. General Shut-off Service - 2" and smaller up to 125 psig

- a. Gate Valves for use in general shut-off service of steam, condensate, water, and oil shall be 125 SWP, 300 WOG, bronze threaded end, rising stem, solid wedge, union bonnet and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	2714
Milwaukee	1151

2. General Shut-off Service - 2½" and larger up to 125 psig

- a. Gate Valves shall be 125 SWP, 200 WOG, cast iron, flanged end bronze trim, rising stem, OS & Y and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	1793
Milwaukee	F-2885-M

3. General Shut-off Service - 2" and smaller over 125 psig

- a. Gate Valves shall be 200 SWP, 400 WOG, bronze threaded end, rising stem, solid wedge, union bonnet and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	2375
Milwaukee	1153

4. General Shut-off Service - 2" and smaller up to 150 psig

- a. Gate Valves shall be 200 SWP, 400 WOG, bronze threaded end, rising stem, solid wedge, stainless or monel seat ring, union bonnet and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	2375
Milwaukee	1153

I. Globe Valves

1. General Modulating Service - 2" and smaller up to 125 psig

- a. Globe Valves for use in general modulating service and steam, condensate, water and oil shall be 150 SWP, 300 WOG, bronze threaded end, union bonnet and gland packed disc material shall be compatible to line media.
- | MANUFACTURER | VALVE NUMBER |
|--------------|--------------|
| Powell | 150-A |
| Milwaukee | 590 |
2. General Modulating Service - 2½" and larger up to 125 psig
- a. Globe Valves shall be 125 SWP, 200 WOG, flanged end, cast iron, OS & Y, rising stem and bronze trim.
- | MANUFACTURER | VALVE NUMBER |
|--------------|---------------|
| Powell | 241 |
| Velan | 0074 C Series |
3. General Modulating Service - 2" and smaller over 125 psig
- a. Globe Valves shall be 200 SWP, 400 WOG, bronze trim, threaded end, union bonnet, gland packed with hard faced stainless seat and disc.
- | MANUFACTURER | VALVE NUMBER |
|--------------|--------------|
| Powell | 110 |
| Milwaukee | 592A |
- J. Check Valves
1. General Service - 2" and smaller up to 125 psig
- a. Check Valves in all piping of steam, condensate, air, gas, water and oil shall be 150 SWP, 300 WOG, bronze threaded end, horizontal swing check design, composition disc compatible to line media and be so designed that it can be used in either the horizontal or vertical position.
- | MANUFACTURER | VALVE NUMBER |
|--------------|--------------|
| Powell | 596 |
| Milwaukee | 510 |
2. General Service - 2½" and larger up to 125 psig
- a. Check Valves shall be 125 SWP, 200 WOG, flanged end, cast iron, swing check and bronze trim.
- | MANUFACTURER | VALVE NUMBER |
|--------------|--------------|
| Powell | 559 |
| Milwaukee | F-2974-M |
3. Check Valves for Pump Discharge - 6" and smaller up to 125 psig
- | MANUFACTURER | VALVE NUMBER |
|---------------------------|--------------|
| Clow | 329 |
| CPV | 10B |
| Mueller (Grinnell) | 101-MAP |
| Durable | WLC Series |
| Conbraco Industries, Inc. | |
| Metaflex Company | |

4. Check Valves for Pump Discharge - 8" and larger up to 125 psig

MANUFACTURER	VALVE NUMBER
Clow	375
CPV	20B
Mueller (Grinnell)	105-MAP
Durable	GLC Series
Conbraco Industries, Inc.	
Metaflex Company	

5. Check Valves for Pump Discharge over 125 psig - All Sizes

MANUFACTURER	VALVE NUMBER
Clow	636
CPV	21B
Mueller (Grinnell)	107-MAP
Durable	GLC Series

K. Butterfly Valves

1. Butterfly Valves for General Shut-Off Service - 2½" and larger up to 125 psig for use with chilled water and condenser water only.

a. Butterfly Valves shall be of the double-tap, lug-style, cast iron body, with ductile iron discs, seats and seals, type 316, stainless steel shafts, secondary shaft seals and nonmetallic shaft bearings, shall be of EPDM for service to 250°F. Valves shall comply to API 609 and MSS-SP67 for use between ANSI class 125 iron and / or ANSI class 150 steel flange. Operator shafts shall be extended to allow clearance for insulation - 6" and smaller shall be lever operated - 8" and larger shall be gear and handwheel operated. All valves shall seal bubble-tight up to 125 psig.

b. Install with shafts in horizontal position.

MANUFACTURER	VALVE NUMBER
Keystone	AR2
Grinnell	
Nibco	HPR with EPDM liner (LD-2000)
Watts	BF 03 with EPDM seat
DeZurik	Fig. 660 with EPDM liner
Milwaukee	M-Series

L. Balancing Valves

1. General Shut-off and Balancing Service for listed equipment - 1/2" - 2" up to 125 psig.

a. The following valves shall be used in general shut-off and balancing service in all run-outs to convectors, unit heaters, radiation, fan coil units, unit ventilators, heaters, induction units, reheat coils, manual control convectors and injection nozzles. Valves shall be capable of a Bubble-Tight Shut Off.

b. All return branches in hot and chilled water lines shall be furnished with balancing valve.

c. Provide preformed insulation boots for all balancing valves. Boots shall be provided by valve manufacturer.

- d. These valves shall have infinite setting devices to prevent reopening past present balancing point when valves are used for shut-off purposes. They shall be threaded end to match piping. Provide key operator and balancing stop.
- e. Valves shall have flow measurement ports to allow balancing. Make sure valves fit in intended space before ordering.

MANUFACTURER	VALVE NUMBER
Armstrong	CBV (with flow measurement ports)
Wheatley	GS (with flow measurement ports)
Tour and Anderson	TA (with flow measurement ports)
Griswold Controls	

- 2. Pipeline shut-off and balancing service for air handling units, pumps and other listed equipment - 2-1/2" - 6" up to 125 psig.

- a. Use also for large piping, air handlers and larger flow.
- b. Double tap lug style bodies shall be used. These valves shall be capable of tight shut-off when in the closed position. Valves shall be complete with locking mechanism that can be set at a balance point so that the valves may be closed and opened, but not opened beyond the preset balance point. Valves shall be furnished with an indicator from 0 to 100% of valve opening. Valve connections shall conform to ANSI standards.
- c. Operator shafts shall be extended to allow insulation to cover the valves or valve manufacturer shall provide preformed insulation boots to match valves.

- d. Valves shall have flow measurement ports to allow balancing.
- | MANUFACTURER | VALVE NUMBER |
|-------------------|-----------------------------------|
| Armstrong | CBV (with flow measurement ports) |
| Wheatley | GS (with flow measurement ports) |
| Tour and Anderson | TA (with flow measurement ports) |

M. Ball Valves

- 1. Ball valves may be used in lieu of gate valves for hot water or chilled water. Ball valves with memory stop may not be used in lieu of balancing valves.
- 2. General Shut-off Service - 2" and smaller up to 125 psig
 - a. Ball valves shall be 150 SWP, 400 WOG, full port, two piece bronze threaded or soldered end, blowout proof stem, stainless steel ball, TFE seat rings, and lever handle - fed. spec. MSS-SP-110. All ball valves shall have extended valve stems to allow full thickness insulation to be installed.

MANUFACTURER	VALVE NUMBER
Apollo	70-100-01
Crane	2180
Hammond	805
Watts Regulator	B6000
Jamesbury	351

- 3. General Shut-off Service - 2" and Smaller up to 150 psig

- a. Ball valves shall be 150 SWP, 400 WOG, full port, two or three piece bronze threaded or soldered end, blowout proof stem, stainless steel ball, TFE seat ring,

full port lever handle - Fed. MSS-SP-110. All ball valves shall have extended valve stems to allow full thickness insulation to be installed.

MANUFACTURER	VALVE NUMBER
Apollo	77-140-01
Apollo (3pc)	82-140-01
Grinnell (2pc)	3700
Grinnell (3pc))	3810
Nibco (3pc)	590 or 595
Pittsburgh Brass	SS-B
Worcester	411T

OR

2.8 PUMP DISCHARGE TRIPLE DUTY VALVES UP TO 125 PSIG - 2" THROUGH 8"

- A. Valves shall be same manufacturer as related pumps. These valves shall be selected for between 3 feet and 5 feet of pressure drop across a wide-open valve at design flow (this may not necessarily yield line sized valve).

MANUFACTURER	VALVE NUMBER
Armstrong	FTA
Bell and Gossett	Triple Duty
Taco	360 series
Thrush	TD series

2.9 DRAIN AND PURGE VALVES

- A. Hose end valves for draining, purging and strainer blow-offs shall not be used. Provide and install full port ball valves with brass adaptor and brass cap.
- B. Forward shop drawings of all valves to Architect / Engineer for review.

2.10 PRESSURE RELIEF VALVES

- A. Pressure Relief Valves for use in all locations where shown or required by codes shall be as follows:

SERVICE	SIZE	TYPE
Boiler Safety and Steam Relief	All	Crosby-Ashton, Style HS Kunkel No. 253, semi-nozzle Consolidated, Style 1902 Watts 740
Water Relief	All	Cash Acme Type F

- B. Relief Valve capacity shall exceed maximum flow rate of upstream flow control device, pressure reducing valve, etc.
- C. Pipe relief valves full size to floor drain.
- D. Forward shop drawings of all valves to Architect / Engineer for review.

2.11 REFRIGERATION PIPING

- A. Refrigeration piping shall be Type ACR hard drawn sealed and nitrogen filled special refrigeration duty copper. Fittings shall be wrought copper streamline fittings and all elbows shall be long radius.
- B. Brazing shall be silver alloy having a minimum melting point of 1185 °F. Piping shall be filled with oil pumped dry nitrogen during all brazing operations.
- C. After the system is installed and before any piping is insulated, the entire refrigeration circuit must be thoroughly leak tested. The following test procedure is recommended:
 - 1. Remove and plug the connection points of any controls or relief valves that could be damaged by test pressure. Since the compressor is not included in the leak test, front seat both the compressor suction and discharge valves. Open the liquid line shutoff valve at the condenser, any auxiliary valves in the hot gas and liquid lines and the liquid solenoid valve(s). If the solenoid valve(s) is not equipped with a manual opening device, apply control power to the solenoid(s), opening the valve(s).
 - 2. Connect a cylinder of oil-pumped, dry nitrogen to the frontseat port of the compressor discharge valve, if the valve is so equipped. If not, make the connection at the liquid line charging valve. Note: It is important that the pressure of the nitrogen be controlled by a reducing valve. Control is absolutely necessary because the pressure within a full cylinder of nitrogen is in excess of 2,000 psi at room temperature.
 - 3. Set the pressure regulator on the nitrogen cylinder at 150 psig or the leak test pressure specified by local code. Open the shutoff valve on the cylinder and the valve of the manifold and charge enough nitrogen into the system to raise the pressure to 150 psig, or to the pressure required by local code. Close the manifold valve.
 - 4. Using a rubber or rawhide mallet, tap each solder connection sufficiently hard to start any leak that might subsequently open from thermal expansion and contraction or vibration.
 - 5. Test all pipe joints for leaks. First, check the manifold gauge. If the pressure is dropping, a major leak is present. Large leaks are detected by the sound of escaping gas. Smaller leaks are located by brushing each connection with a soap solution and watching for tell-tale bubbles. Adding a small amount of glycerine to the soap solution improves the bubbling action. Make certain that all joints are inspected thoroughly. Mark carefully any spots where leaks occur.
 - 6. After the bubble test is completed, close the cylinder shutoff valve and bleed the test pressure through the unused part of the manifold. Repair any leaks found. Leaks are repaired by disassembling the connection, cleaning the fitting and remaking. No attempt should be made to repair a leak by simply adding brazing material.
 - 7. After the system is assumed to be free of leaks, charge enough refrigerant through the liquid line charging valve to raise the system pressure to approximately 10 psig. Remove the refrigerant connection and charge enough nitrogen into the system to raise the test pressure to 150 psig or to the local code requirement.
 - 8. Check all parts of the system with a halide torch or electronic leak detector. The presence of escaping refrigerant will color the flame of the halide torch green if the leak is small or a dense blue if it is large. An electronic leak detector indicates the presence of a leak by either a gauge reading, signal light or an audible sound. If any leaks are found, relieve the test pressure and repair the faulty area. Recharge the system, as described previously, and allow it to remain under pressure for 24 hours. If, at the end of this period, there is no appreciable pressure change, the system may be considered free of leaks. Note: The

system pressure will change approximately 3 psig with each 10°F rise or fall in ambient temperature.

9. With the testing complete, relieve the test pressure and reconnect any valves or controls that were disconnected previously.

D. Evacuation

1. To speed the evacuation, connect the vacuum pump to as many points of the system as possible. To register the vacuum developed by the pump, a reliable vacuum gauge, such as a Zimmerli Gauge or an electronic vacuum gauge, is connected to the liquid line charging valve. The compressor valves are then cracked off of their backseats, moving the valve disc to an intermediate position between the backseat and the frontseat of the valve. Open the liquid line charging valve.
2. The vacuum pump shall be started and operated until a vacuum equivalent to 500 microns is registered by the vacuum gauge. The length of time required to achieve the 500 micron reading depends upon the size of the system and the amount of moisture within the system. Failure to reach the required vacuum reading may be due to:
 - a. Presence of a large amount of moisture. This will be removed with continued operation of the vacuum pump.
 - b. Inefficiency of the pump. Leaks within the pump or contaminated pump oil may be the cause. This may be checked by operating the pump against a vacuum gauge.
 - c. A system leak.
3. When the system has been evacuated, close the suction valve on the vacuum pump and then stop the pump. Backseat one of the compressor valves and remove the vacuum pump connection. Through this valve port charge enough oil-pumped dry nitrogen into the system to raise the pressure to atmospheric. Re-evacuate the system. Any moisture remaining in the system is absorbed by the dry nitrogen gas and is removed by the second evacuation.
4. After the 500 micron vacuum reading has been re-established, close the vacuum pump suction valve and stop the pump. Backseat the compressor valves and allow the system to stand under vacuum for a minimum of 12 hours. If the vacuum reading remains unchanged, the system is ready to receive its charge of refrigerant.

E. Charge system with proper quantity of refrigerant and lubricant.

F. Insulate suction line with foamed plastic insulation. See Specification Section 22 00 20.

G. Forward shop drawing submittals to Architect / Engineer for review. Submittal shall include complete sketch of refrigerant piping system, sizes, fittings and lengths. Indicate on sketch that manufacturer approves layout and that warranty applies. (Contractor shall note that pipe sizes and layouts on drawings are for the purpose of establishing a bid price. Final sizing and layout shall be determined and approved by refrigeration equipment manufacturer.)

H. Refrigerant purge and relief shall be piped full size in separate lines to outdoors using materials specified for refrigerant piping.

2.12 REFRIGERATION ACCESSORIES

- A. Furnish and install the following specialties in refrigeration piping from each unit:
1. 1 - liquid line catch-all filter-drier sized for 2 psi maximum pressure drop (with 3-valve bypass).
 2. 1 - solenoid valve with 120 volt, 60 cycle coil on each refrigerant circuit.
 3. 1 - expansion valve with external equalizer on each refrigerant circuit.
 4. 1 - liquid indicator with moisture indicating bull's-eyes in each circuit immediately upstream of expansion valve.
 5. Charging valves.
 6. Hot gas discharge muffler in each compressor circuit. Muffler shall be suitable for horizontal or vertical installation, self-draining.
- B. Acceptable Manufacturers
1. Mueller Brass Company
 2. Henry Valve Company
 3. Sporlan

2.13 REFRIGERANTS - GENERAL

- A. Recover and Recycle Refrigerants
1. Refrigerant used in centrifugal water chillers should be recovered and / or recycled for reuse, reprocessed (reclaimed), or properly disposed of, whenever it is removed from the equipment. Never release to atmosphere!
 2. Always determine recycle or reclaim requirements of the refrigerant before beginning recovery procedure. Obtain a chemical analysis of the refrigerant if necessary. (Questions about recovered refrigerant and acceptable refrigerant quality standards are addressed in ARI Standard 700.)
- B. Refrigerant Handling and Safety
1. Consult manufacturer's Material Safety Data Sheets (MSDS) on refrigerants being handled to understand health, safety, storage, handling and disposal requirements. Use approved containment vessels and refer to appropriate safety standards. Comply with all applicable transportation standards when shipping refrigerant containers.
- C. Service Equipment and Procedures
1. To minimize refrigerant emissions while recovering the refrigerant, use recycling equipment such as a Trane "recycle / recovery system" or equivalent. Use equipment and methods which will pull the lowest possible system vacuum while recovering and condensing refrigerant. Equipment capable of pulling a vacuum of less than (500 microns - 1.0 mm) of mercury is recommended. Do not open the unit to atmosphere for service work until the refrigerant charge is fully removed/recovered.
 2. Evacuation prior to charging should be done with a vacuum pump capable of pulling a vacuum of (500 microns - 1.0 mm) of mercury or less. The unit should stand for 12 hours and the vacuum should not rise above 2,500 microns (2.5 mm) of mercury. A rise above 2,500 microns (2.5 mm) of mercury indicates a leak test is required to locate and repair any leaks. A leak test will be required on any repaired area. Charge refrigerant into the machine only when it is determined that the machine does not leak or contain moisture.

Charge refrigerant into the machine by weight. A proper charge is required for efficient machine operation. When charging is complete, purge or drain charging lines into an approved refrigerant container. Seal all used refrigerant containers with approved closure devices to prevent unused refrigerant from escaping to the atmosphere. Take extra care to properly maintain all service equipment directly supporting refrigerant service work such as gauges, hoses, vacuum pumps, and recycling equipment.

3. When cleaning system components or parts, avoid using CFC-11 (R-11) or CFC-113 (R-113). Use only cleaning solvents that do not have ozone depletion factors. Properly dispose of used materials. Refrigeration system cleanup methods using filters and driers are preferred.

2.14 WATER CIRCULATING PUMPS - Base Mounted

- A. Provide horizontally or vertically split-casing type circulating pumps as scheduled on drawings, arranged to permit access to revolving parts without disconnecting suction and discharge piping or moving motor. Pumps shall be fitted with grease lubricated ball bearings to zerk fittings and drain plugs in dust and moisture proof housing, machine fitted to assure permanent, perfect alignment (cast iron casing with bronze fittings). Renewable bronze casing wearing rings shall be provided. Pumps shall be equipped with mechanical seals (and stainless steel shaft sleeves). Provide bronze impeller. Manufacturer shall especially note arrangement of piping for high static heads and shall check the water condition at job site before recommending type of seal or packing gland.
- B. Each pump shall deliver the total gpm listed in the schedule against the total dynamic head listed, and pump characteristic curve shall have a cut-off point at a head no more than 20% or less than 10% above rated discharge head.
- C. The pump shall be mounted on a cast iron or fabricated steel drip-lip subbase and direct connected by Dodge Para-Flex, Woods, Falk or Waldron flexible coupling to the electric motor.
 1. See Section 23 0500 for further motor requirements.
- D. Mount base with assembled pump and motor on 3½" thick concrete housekeeping base. Base of pump shall be tightly packed with wet grout after pump is aligned, leveled and anchored. Install standpipe minimum of 12" high over grout pouring hole to assure that all areas of base are filled. Each pump shall be mounted on an inertia base.
- E. The manufacturer of all pumps shall be responsible for the supervision of the pump installation and field alignment to make sure pumps installed are to their requirements. Submit alignment report to Architect / Engineer stating pumps are properly aligned.
- F. Suction diffusers with integral strainers shall be provided by the pump manufacturer. Diffusers shall match pumps and shall be provided with support foot and pressure gauge taps.
- G. Acceptable Manufacturers
 1. Armstrong
 2. Bell and Gossett
 3. Aurora
 4. Pacific Pump Company
 5. TACO, Inc.

6. Thrush

- H. Forward shop drawing submittals to the Architect / Engineer for review. Include pump curve with operating point plotted.
- I. Each pump shall be equipped with a VFD. Acceptable VFD manufacturers include ABB, Square D and Dan Foss. The VFD shall be provided by the Contractor.

2.15 WATER TREATMENT

A. Circulating Hot Water Systems

- 1. Provide and install bypass "shot" feeders welded steel construction with 300 psig working pressure. Feeders shall be installed in all new HW systems and have the following features.
 - a. 5 gallon capacity
 - b. 3.5" fill port with quick opening cover
 - c. 3/4" inlet and outlet connections
 - d. 3/4" vent connection
 - e. Safety cover that cannot be removed while feeder is pressurized
- 2. Shot feeders shall be piped in accord with manufacturer's details.
- 3. Acceptable Manufacturers
 - a. Nalco
 - b. Betz
 - c. Dearborn
 - d. JL Wingert Co.

- B. Forward shop drawing submittals to the Architect / Engineer for review.

2.16 EXPANSION JOINTS (Packless Type)

- A. Furnish and install Flexonics type Tube Turns telescopic expansion joints with 2-ply stainless steel bellows for all piping 2.50" and smaller where shown on drawings, or required for expansion of pipes and space does not permit use of fabricated expansion loops.
- B. Furnish and install Flexonics single or dual flexing, as shown on drawings, Tube Turns or ADSCO controlled flexing packless expansion joints with Type 304 stainless steel bellows for all piping 3" and larger where shown on drawings, or required for expansion of pipes and space does not permit use of fabricated expansion loops.

2.17 FLEXIBLE PIPE CONNECTORS

- A. Furnish and install molded "Teflon" flanged flexible couplings on suction and discharge connection of all piping deflections. Furnish connections complete with companion flanges, grommeted limit bolts and monel reinforcing rings.
- B. Connectors shall be suitable for continuous operation at 220 °F with pressures of 110 psig.

- C. Acceptable Manufacturers
 - 1. Belmont
 - 2. Garlock Inc.
 - 3. John Dore Co.
 - 4. Mercer
 - 5. Metraflex
 - 6. Resistoflex
 - 7. Flex Flo (Thermatech)

- D. Forward shop drawing submittals to the Architect / Engineer for review.

2.18 CENTRIFUGAL PUMPS WITH FLOOR-MOUNTED RECEIVER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ITT Corporation; Domestic Pump Division.
 - 2. Roth Pump Company.
 - 3. Skidmore Pump.
 - 4. Spence Engineering Company, Inc.; Division of Circor International, Inc.
 - 5. Spirax-Sarco Inc.
 - 6. Sterling.

- B. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pumps, controls, and accessories suitable for operation with steam condensate.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. ASME Compliance: Fabricate and label steam condensate receivers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

- C. Configuration: Duplex floor-mounted pumps with receiver and float switches;

- D. Receiver:
 - 1. Floor mounted.
 - 2. Close-grained cast iron.
 - 3. Externally adjustable float switches.
 - 4. Flanges for pump mounting.
 - 5. Water-level gage and dial thermometer.
 - 6. Pressure gage at pump discharge.
 - 7. Bronze gate valves between receiver and pump discharge.
 - 8. Lifting eyebolts.
 - 9. Inlet vent and an overflow.
 - 10. Cast-iron inlet strainer.

- E. Pumps:
 - 1. Centrifugal, close coupled.
 - 2. Vertical design, permanently aligned, and bronze fitted.

3. Stainless-steel shafts.
 4. Mechanical seals rated at 250 deg F.
 5. Rated to operate with a minimum of 2 feet of NPSH.
 6. Mounted on receiver flanges.
- F. Motor:
1. Enclosure: Totally enclosed, fan cooled.
 2. Motor Bearings: Grease-lubricated ball bearings.
 3. Efficiency: Premium efficient.
- G. Control Panel:
1. Factory wired between pumps and float switches, for single external electrical connection.
 2. Provide fused, control-power transformer if voltage exceeds 230 V ac.
 3. NEMA 250, Type 1 enclosure with hinged door and grounding lug, mounted on pump.
 4. Motor controller for each pump.
 5. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
 6. Manual lead-lag control to override electrical pump alternator and manually select the lead pump.
 7. Momentary-contact "TEST" push button on cover for each pump.
 8. Numbered terminal strip.
 9. Disconnect switch.

PART 3 - EXECUTION

3.1 DEMOLITION

- A. Contractor shall remove all existing materials, system components, accessories and related items that will not be re-used.
- B. Contractor shall ensure that system is inactive before disabling the system. Contractor shall ensure that removal of system will not compromise the Owner's operations before removal occurs.
- C. Partial removals shall extend back to nearest active main. Provide and install caps or pipe plugs at main.
- D. No piping shall be left open as a result of demolition operations. Cap or plug all open piping. Crimping is not an acceptable means of capping piping.
- E. Refrigerant associated with demolished systems/equipment shall be reclaimed by Contractor in accord with applicable regulations. Such refrigerant becomes the property of the Contractor unless stated otherwise.
- F. All hangers and clamps shall be removed as part of demolition work if they are not re-used.
- G. All removed equipment and materials become the property of the pertinent removing Contractor unless otherwise noted.

3.2 DRAIN LINES

- A. Contractor shall provide and install a complete drain system from all coil drain pans in all air handling units, fan coils, evaporator coils and cooling coils. On double sloped pans and / or pans with two drain connections provide drains on both sides.
 - 1. Where multiple, stacked cooling coils are used each coil shall have its own drain pan. Provide internal drop tubes from each such pan down to the main drain pan.
- B. All drains shall be trapped. Traps shall be designed to withstand the maximum (positive or negative) pressures imposed on them by service without ponding or retaining water in the pans .
 - 1. Dimension from bottom of pan outlet to trap invert shall be equal to two times unit static pressure (in inches of water) plus unit velocity head (in inches of water).
 - 2. Dimension from bottom of trap to trap outlet shall be equal to two times unit static pressure (in inches of water).
- C. Drain lines shall be the same size as the pan outlet connections.
- D. All drain lines shall slope uniformly to termination point at slope of 1/8" per foot.
- E. Terminate drain lines at floor drains with indirect connection.

3.3 PIPE GUIDES AND ANCHORS

- A. Where expansion joints are used, pipes shall be guided two times on each side of the expansion joint. The guides shall be from 5'-0" and 25'-0" from the anchor unless otherwise noted on drawings. Guides shall be reviewed by the Architect / Engineer and shall be so designed as to prevent pipe movement in any direction except along the axis of the pipe run. Also provide guides on vertical pipes in shafts where indicated.
- B. Anchors shall be constructed of steel, shall be such as to prevent pipe movement in any direction, shall be welded to the pipe and shall be securely fastened to the building structure as reviewed by the Architect / Engineer and shall have sufficient strength to withstand the stress that it will be subjected to by the pipe movement.

3.4 WELDING

- A. If requested, furnish proof of the competency of each welding operator and, at the request of the Architect / Engineer, have all or any of the welding operators pass a standard qualification test such as ASME, AWS or Hartford Insurance Company procedure and tests. See Specification Section 22 00 10.

3.5 PRESSURE TESTS

- A. All testing equipment, labor and accessories shall be provided by the Contractor.
- B. Contractor shall disconnect or valve-off all equipment items that could be damaged by testing. All damage resulting from testing shall be the responsibility of the Contractor.

- C. All tests shall be performed before systems are concealed in building construction by insulation or otherwise made inaccessible.
- D. All leaks shall be repaired. Leaking systems shall be repaired and retested until systems are free of leaks. All damage resulting from leaks shall be the responsibility of the Contractor.
- E. Tests shall be witnessed by the Architect / Engineer or designated representative.
- F. Submit 3 copies of test reports to Architect / Engineer for record purposes. Tests shall be typewritten, shall be signed by the Contractor and shall list name(s) of witness(es).
- G. Tests shall be conducted using clear water as the testing media except for refrigeration and compressed air piping. See "Refrigeration piping" for testing of refrigeration piping. Use compressed air for testing of compressed air piping.
- H. All new piping shall be tested by pump pressure to a working pressure of not less than 100 psig. Where operating pressures exceed 50 psig, test pressure shall be two times the working pressure. Test duration shall be two hours for water tests, 8 hours for air tests.
- I. After tests are satisfactorily completed, the piping shall be drained, equipment reconnected and the system made ready for use.

3.6 CLEANING THE PIPING SYSTEMS

- A. At completion of installation and before final capacity tests are conducted, thoroughly clean all grease, oil and dirt from all parts of the new piping in a manner satisfactory to the Architect / Engineer.
- B. Flush entire new steam and condensate system with full steam pressure for a period of two hours.
 - 1. Remove trap interiors during cleaning and temporary piping shall be installed to vent steam to outside.
 - 2. After the steam and condensate systems have been flushed, put system back in normal operation with condensate going to drain for a period of one week.
 - 3. Thoroughly clean all new traps after the plant has been in continuous operation for a period of thirty (30) days. Clean trap interiors and remove all foreign matter.
 - 4. Examine and clean all of the new trap strainers and new strainers for all automatic valves.
- C. Cleaning of Chilled/Hot Water Systems
 - 1. Chilled water and hot water heating systems shall be chemically cleaned by one of the methods outlined below:
 - a. Trisodium Phosphate-Caustic
The system shall be filled with water and for every 100 gallons of system volume, 3 lbs. of trisodium phosphate and 3 lbs. of sodium hydroxide shall be added. This solution shall be circulated for 12 to 24 hours, at 120 °F if possible. At end of circulation time begin flushing as outlined below in Section 2. CAUTION: This procedure shall not be used if metals such as aluminum or galvanized are present

in the system. The alternate methods “b” or “c” outlined below shall be used in these systems.

b. Acrysol QR-1086 and Dequest 2010

The system shall be filled with water and for every 100 gallons of system volume, 2 gallons of cleaning concentrate shall be added. The cleaning concentrate shall be prepared as follows. In 100 gallons of water, add the following quantities of chemicals in the following order and mix thoroughly until dissolved. Use a polyethylene drum:

(1)	Acrysol QR-1086 (Rohm & Haas)	41.5 lbs
(2)	Dequest 2010 (Monsanto)	41.5 lbs
(3)	Potassium or Sodium Hydroxide	12.5 lbs

The cleaning solution shall be circulated in the system for 24 to 48 hours, preferably under light heat (120 °F). If heat cannot be applied then circulate for 48 hours under ambient conditions. At completion of circulation time begin flushing of system as outlined below in Section 2.

c. Drewspers 4945 / Drewspers 4395

These are preblended proprietary cleaning chemicals. Drewspers 4945 is a combination of polymers, chelate, and a gluconic acid derivative designed to remove iron and copper oxides from the system. Drewspers 4395 is a nonionic surfactant which effectively removes silt, mud, clay, oil and other suspended matter from the system allowing them to be carried out of the system by flushing. To clean a system with this procedure, add 1 gallon of Drewspers 4945 and 1 gallon of Drewspers 4395 per 100 gallons of system volume. If foaming problems develop, the use of an antifoam such as Dow Corning Antifoam A should overcome the foaming tendency of Drewspers 4395. Circulate cleaning solution for 48 hours, at a temperature of 120 °F if possible. If heat cannot be applied increase cleaner circulation time to 72 hours. After circulation time begin high velocity flushing as outlined below.

2. A temporary connection to city water with backflow prevention shall be provided to enable high velocity flushing of system. At completion of required cleaner circulation time begin continuous flushing of system while maintaining system full at all times to prevent the introduction of air into the system. Following cleaning, submit samples of system water to independent testing lab to determine if system has been cleaned properly. When cleaning system, ensure that all automatic valves are open to coils so the entire system will circulate and be cleaned. Also remove and clean system strainers following cleaning.

- a. Contractor shall be responsible for providing the necessary pumping action to obtain a minimum velocity of 3 ft / sec in the piping being cleaned. Contractor shall be responsible for providing all bypasses and temporary piping necessary to clean the entire system(s).

3. After final cleaning, add 0.5 oz of Nalco 8325 (or approved equal) per gallon of system volume, to provide a nitrite level of 500 to 750 parts per million. This is a glycol compatible blend of corrosion inhibitors and will passivate the cleaned metal surfaces and protect them from corrosion. If filling the system with ethylene glycol, drain only the volume from

the system necessary to allow the introduction of glycol into the system. If glycol is not to be added, this blend of inhibitors must be left in the system.

a. It may require 5 to 10 times the system volume to adequately flush the system. In order to properly clean a system, a minimum velocity of 3 ft per second must be attained in the system piping. If this velocity cannot be developed then manual cleaning methods will have to be used in those areas where this velocity is not achieved.

4. In systems which require the use of ethylene glycol based antifreeze solutions to prevent possible freezing and bursting of system piping, the glycol used to fill the system shall be as specified elsewhere.
5. Samples submitted to the independent testing laboratory shall meet the following test limits before acceptance of the system.

Chloroform extractables	5 PPM (mg/l) or less
Particulate matter	25 PPM (mg/l) or less
	on 1.2 micron media
Corrosion inhibitors	500-1000 as Nitrite
Glycol	To percentage as per project specification.

3.7 CIRCULATION (WATER SYSTEM)

- A. Insure a perfect and noiseless circulation of water and air throughout entire new water system, without pounding or air binding, in any part of the system when operating at gauge pressures varying from 1/4 to 75 lbs.
- B. Arrange all piping to drain by gravity. Provide drain valves with hose connections at all low points in the system, in all isolated sections of piping, at the base of all risers and downstream of all isolation valves.
- C. Properly vent all high points in hot water heating and chilled water piping systems.

3.8 EXPANSION JOINTS

- A. Install an expansion joint in each HPS riser.

END OF SECTION 23 05 00

SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Insulation: Class F.
- H. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.

3. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 05 13

SECTION 23 05 19 – METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.
 - 6. Test-plug kits.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Product Certificates: For each type of meter and gage, from manufacturer.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide thermometer or comparable product by one of the following:
 - 1. Ashcroft Inc.
 - 2. Ernst Flow Industries.
 - 3. Miljoco Corporation.
 - 4. Tel-Tru Manufacturing Company - AA575R.
 - 5. Trelice, H. O. Co.
 - 6. Weiss Instruments, Inc. - 5VBM.
- B. Standard: ASME B40.200.

- C. Case: Sealed type; stainless steel with 3-inch or 5-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle with unified-inch screw threads.
- F. Connector Size: ½ inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

2.2 DUCT-THERMOMETER MOUNTING BRACKETS

- A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 THERMOWELLS

- A. Thermowells:
 - 1. Standard: ASME B40.200.
 - 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 3. Material for Use with Copper Tubing: CNR or CUNI.
 - 4. Material for Use with Steel Piping: CRES.
 - 5. Type: Stepped shank unless straight or tapered shank is indicated.
 - 6. External Threads: NPS ½, NPS ¾, or NPS 1, ASME B1.20.1 pipe threads.
 - 7. Internal Threads: ½, ¾, and 1 inch, with ASME B1.1 screw threads.
 - 8. Bore: Diameter required to match thermometer bulb or stem.
 - 9. Insertion Length: Length required to match thermometer bulb or stem.
 - 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
 - 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Basis-of-Design Product: Subject to compliance with requirements, provide gage(s) or comparable product by one of the following:
 - a. AMETEK, Inc.; U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Miljoco Corporation.
 - e. Tel-Tru Manufacturing Company.
 - f. Trerice, H. O. Co.
 - g. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch NOMINAL DIAMETER (6-inch if mounted more than 10 feet above floor).
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/4 pipe threads.
- C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.

- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- I. Install thermometers in the following locations:
 - 1. Where indicated on drawings.
- J. Install pressure gages in the following locations:
 - 1. Suction and discharge of each pump.

3.2 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Piping: 0 to 250 deg F.
- B. Scale Range for Air Ducts: Minus 40 to plus 110 deg F.

3.3 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Piping: 0 to 100 psi.

END OF SECTION 23 05 19

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

1. AAA Technology & Specialties Co., Inc.
2. Bergen-Power Pipe Supports.
3. B-Line Systems, Inc.; a division of Cooper Industries.
4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co.
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
10. National Pipe Hanger Corporation.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.

14. Tolco Inc.

- B. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.
 - 5. Thomas & Betts Corporation.
 - 6. Tolco Inc.
 - 7. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.

- D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.
 - d. MKT Fastening, LLC.
 - e. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS ½ to NPS 30.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS ¾ to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS ½ to NPS 24, if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS ½ to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS ¾ to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS ½ to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS ½ to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS ½ to NPS 2.
 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS ¾ to NPS 8.
 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS ¾ to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS ½ to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

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

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 23 05 48 – VIBRATION AND SEISMIC CONTROLS FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

- 1. Isolation pads.
- 2. Spring isolators.
- 3. Restrained spring isolators.
- 4. Channel support systems.
- 5. Restraint cables.
- 6. Hanger rod stiffeners.
- 7. Anchorage bushings and washers.

- B. Related Sections include the following:

- 1. 21 0548 - Vibration and Seismic Controls for Fire Protection Systems
- 2. 22 0548 - Vibration and Seismic Controls for Plumbing Systems
- 3. 26 0548 - Vibration and Seismic Controls for Electrical Systems

1.3 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:

- 1. Site Class as Defined in the IBC: D.
- 2. Assigned Seismic Occupancy Category as Defined in the IBC: II.
- 3. Spectral Response Acceleration:
 - a. S_s: 67.0%g.
 - b. S₁: 18.4%g.

4. Seismic Design Category: D.
5. Spectral Acceleration:
 - a. Sds: 0.565
 - b. Sd1: 0.253
6. Component Importance Factor:
 - a. At the existing Wabash General Hospital all equipment, devices, fixtures and pipping shall have an Component Importance Factor of 1.5.
 - b. At the existing Ortho Building and new Medical Office Building all equipment, devices, fixtures and pipping shall have an Component Importance Factor of 1.0.
7. Component Acceleration Factor and Component Response Modification Factor shall be determined by appropriate Seismic Coefficient table in ASCE 7-10.

1.5 SUBMITTALS

- A. Product Data: For the following:
 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 3. Field-fabricated supports.
 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

- c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- D. Welding certificates.
- E. Manufacturer Seismic Qualification Certification: Submit certification that equipment accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 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.
- F. Qualification Data: For professional engineer and testing agency.
- G. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ace Mountings Co., Inc.
 2. Amber/Booth Company, Inc.
 3. California Dynamics Corporation.
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control.
 6. Mason Industries.
 7. Vibration Eliminator Co., Inc.
 8. Vibration Isolation.
 9. Vibration Mountings & Controls, Inc.
- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene, rubber or hermetically sealed compressed fiberglass.
- C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
 2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 4. Hilti Inc.
 5. Loos & Co.; Seismic Earthquake Division.
 6. Mason Industries.
 7. TOLCO Incorporated; a brand of NIBCO INC.
 8. Unistrut; Tyco International, Ltd.

- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipes and Ducts: Secure pipes and ducts to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on HVAC equipment.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: Anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
 9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 48

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Outdoor Equipment:

1. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped 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. Plastic Labels for Indoor Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Blue.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 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.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus 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, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

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

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. 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.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. 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.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full 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. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 VALVE TAGS

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

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Pipe Label Schedule:

- 1. Hot Water Supply Heating.HWSH
- 2. Hot Water Return Heating.HWRH
- 3. Vents.V
- 4. Drain.D
- 5. Refrigerant Liquid. RL
- 6. Refrigerant Suction. RS
- 7. Chilled Water Supply.CHWS
- 8. Chilled Water Return.CWR

- a. Background Color: Green.
- b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves and valves within factory-fabricated equipment units. List tagged valves in a valve schedule.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

SECTION 23 05 93 – PIPING AND AIR SYSTEMS TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Contractor: Test, adjust and balance air and piping systems. Work includes but is not limited to the following.
2. Test and Balance
 - a. Hydronic systems
 - b. Air systems
 - c. Control system tests
 - d. Reports

1.2 RELATED WORK

A. Specified elsewhere:

1. Sections: Architectural / Structural and General Work:
2. Division 23 - Mechanical
3. Division 26 - Electrical

1.3 JOB CONDITIONS

- A. Heating, ventilating, and air conditioning equipment shall be completely installed and in continuous operation to accomplish the testing, adjusting and balancing work specified. Complete air balancing prior to hydronic balancing.
- B. Perform testing, adjusting and balancing when outside conditions approximate design conditions for heating and cooling functions or when the system is operating at design capacity.
- C. The Architect / Engineer may be present during testing and balancing to verify that specified procedures are followed.

1.4 QUALITY ASSURANCE

- A. Testing and balancing shall be performed by independent firms specializing in such work.
 1. The Contractor shall not be related to the Subcontractor in any business enterprise.
- B. Only qualified personnel shall perform testing and balancing work.
- C. Submit evidence that the personnel who will perform the testing and balancing of the project systems are qualified personnel for review by the Architect / Engineer prior to performing the work.
- D. Submit a list of completed projects successfully tested and balanced by the submitted qualified personnel for review by the Architect / Engineer, prior to performing the work.

- E. Perform all corrective measures caused by faulty installation. Retest, readjust and rebalance systems until satisfactory results are achieved.

1.5 DEFINITION

- A. Qualified personnel are:
 - 1. Personnel who have been certified by one of the following test and balance organizations.
 - a. AABC - Associated Air Balance Council.
 - b. Certified TBAB - Certified Testing, Balancing and Adjusting Bureau.
 - c. NEBB - National Environmental Balancing Bureau, Illinois Chapter.
 - d. SMARTA - Sheet Metal, Air Conditioning & Roofing Contractors Trade Association of Illinois.
 - e. TABIC - Test & Balancing Institute for Certification.

1.6 SUBMITTALS

- A. Submit data sheets on each item of testing equipment for Architect / Engineer review. Include name of device, manufacturer's name, model number, latest date of calibration and correction factors.
- B. Submit a report containing all test data and other related information recorded during testing and balancing, placed on appropriate forms for Architect / Engineer review. Reports shall certify that the methods used and results achieved are as specified.

1.7 REVERIFICATION

- A. During Substantial Completion Inspection, a percentage (not more than 5%) of the recorded data will be subject to reverification by the Architect / Engineer. Take instrument readings as directed. Test points will be in normally accessible locations and randomly selected by Architect / Engineer.

PART 2 - PRODUCTS

2.1 WATER BALANCING INSTRUMENTS

- A. 30" Mercury U-Tube Manometer, 200 psig wwp, with three valve bypass assembly and return wells or mercury check valves.
- B. Inspector's Gauge Testing Set.
- C. Water Differential Pressure Gauge, 4.50" dial.
- D. Pressure gauge measurements points, quick-connect couplings, 1/4" ips.

2.2 AIR BALANCE INSTRUMENTS

- A. Velometer with probes and Pitot tube.
- B. Rotating vane anemometer.

- C. ASHRAE standard Pitot tubes stainless steel 5/16 outside diameter, lengths 18" and 36".
- D. Magnehelic differential air pressure gauges, 0 to 0.5", 0 to 1.0" and 0 to 5.0" water pressure ranges, each arranged as a portable unit for use with a standard Pitot tube.
- E. Combination inclined-vertical portable manometer, range 0 to 5.0" water.
- F. Portable-type hook gauge, range 0 to 12" water.
- G. Portable flexible U-tube manometer, magnetic mounting clips, range 0 to 18" water.
- H. Conical or pyramidal shaped hood.

2.3 SYSTEM PERFORMANCE MEASURING INSTRUMENTS

- A. Insertion thermometers, with graduations at 0.1 °F or contact pyrometer.
- B. Sling psychrometer.
- C. Tachometer, centrifugal type.
- D. Revolution counter.
- E. Clamp-on volt-ammeter.
- F. Recorders, portable type for temperature and humidity.

PART 3 - EXECUTION

3.1 DRIVES

- A. All VAV systems shall be provided with new, appropriately sized drives such that the full range of the pertinent VFD's is available for control of duct static pressure. VAV systems shall not be balanced using the VFD's.

3.2 AIR SYSTEMS

- A. Test, adjust and balance systems in accord with the following:
 - 1. Preliminary:
 - a. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals. Inspect all system components for proper installation and operation.
 - b. Use manufacturers' ratings for all equipment to make calculations except where field test shows ratings to be impractical.
 - c. Verify that all instruments are accurately calibrated and maintained.
 - d. Install clean filters.
 - 2. Central System:

- a. Test, adjust and record supply, return fan RPM to design requirements within the limits of mechanical equipment provided.
 - b. Test and record motor voltage and running amperes including motor nameplate data and starter heater ratings.
 - c. Make pitot tube traverse of main supply, exhaust and return ducts, determine and record cfm at fans and adjust fans to design cfm.
 - d. Test and record system static pressure, suction and discharge.
 - e. Test and adjust system for design minimum outside air, cfm.
 - f. Test and adjust systems for design return air, cfm.
 - g. Test and record heating apparatus entering air temperatures, dry bulb.
 - h. Test and record cooling apparatus entering air temperatures, dry bulb and wet bulb.
 - i. Test and record heating apparatus leaving air temperatures, dry bulb.
 - j. Test and record cooling apparatus leaving air temperatures, dry bulb and wet bulb.
3. Distribution: Adjust zones or branch ducts to proper design cfm, supply and return.
 4. Air Terminals:
 - a. Identify each air terminal from reports as to location and determine required flow reading.
 - b. Test and adjust each air terminal to within 10% of design requirement.
 - c. Test procedure on air terminals shall include comparison of specified fpm velocity and observed velocity, adjustment of terminal and comparison of specified cfm and observed cfm after adjustment.
 - d. Adjust flow patterns from air terminal units to minimize drafts to extent design and equipment permits.
 5. Verification:
 - a. Prepare summation of readings of observed cfm for each system, compare with specified cfm and verify that duct losses are within specified allowable range. Determine coil and filter static pressure drops.
 - b. Verify design cfm at fans as described above.

3.3 TESTING, BALANCING AND ADJUSTING

- A. At the completion of the installation of the air distribution systems, the following tests shall be made.
- B. All instruments for testing are to be furnished by this Contractor and must be reviewed by the Architect / Engineer before use on job. All readings shall be recorded on approved forms. All instruments used shall be recently calibrated and same set of instruments shall be used throughout the balancing procedures.
- C. The air distribution systems shall be balanced with the volume dampers, splitter dampers and adjustable air extractors in the duct systems as follows:
 1. All air handling equipment in building shall be operating during the balancing procedures. Supply systems with return fans shall be balanced in the 100% outside air position. System shall then be set in minimum outside air position and manual volume damper after

- automatic return air dampers adjusted to maintain constant supply air volume. Supply systems without return fans shall be adjusted to the minimum outside air position. All filters shall be new and clean. All volume dampers and extractors shall be set at 2/3 open position.
2. Fans shall be adjusted to specified air quantities by using rotating vane anemometer traverse over entering air face of cooling coils in built-up air handling systems, with pitot tube and inclined manometer or a velometer having proper duct jet attachment for traverse at fan inlet.
 3. Individual outlets shall be adjusted to specified air quantities using either the "proportional method" starting at last outlet and working towards main or the "trial and error" method, with a velometer having proper attachment or a rotating vane anemometer.
 4. Branch ducts (having more than one outlet) shall be adjusted to specified air quantities by using a pitot tube and inclined anemometer or a velometer having proper duct jet attachment for traverse as near to takeoff as practical.
 5. Above procedures shall essentially be followed for all systems and shall be repeated until proper balance is achieved throughout systems from -0% to +10% of specified air quantities.
- D. After balance is completed, lock nuts or stop screws shall be installed at all volume dampers and extractors to permit them to be shut-off but prevent opening beyond the set balance position.
- E. For more detailed step-by-step procedures the Balancing and Adjustment Manual for Air Distribution Systems published by Sheet Metal and Air Conditioning Contractors National Association shall be used.
- F. All readings taken throughout the balancing procedure shall be recorded on approved forms and upon completion of balancing and testing shall be "certified" as being correct and submitted for review.
- G. Upon receipt of "certified" balancing forms and letter of certification that all balancing, testing and adjusting is completed in accordance with plans and specifications and that all systems are operating properly, the Architect / Engineer or his designated representative will conduct a balance inspection. Furnish personnel, instruments and equipment as required to assist the Architect / Engineer during this "balance inspection".
- H. If during the above balance inspection any portion of any system is found in improper balance, that entire system shall be rebalanced and a new report submitted. The rebalance shall be checked and if again found in improper balance, this Contractor shall again rebalance and submit report. This procedure shall be repeated until the systems are properly balanced to the satisfaction of the Architect / Engineer.

3.4 HYDRONIC HEATING SYSTEMS

- A. Test, adjust and balance system in accordance with the following requirements:
1. Preliminary:
 - a. List all mechanical specifications of tested equipment and verify against contract documents. Inspect all system components for proper installation and operation. Clean all screens.

- b. Open all line valves to full open position. Close coil bypass stop valves, then set mixing control valve to full coil flow.
- c. For each pump, verify rotation, test, and record pump shut-off head, and test and record pump wide-open head.
- d. Verify proper water level in expansion tanks and in the system. Verify that system is entirely full of fluid. Vent all air vents.
- e. Verify that air vents in high points of water systems are installed and operating freely.
- f. Verify that all instruments are accurately calibrated and maintained.

2. Central Equipment:

- a. Set chilled water and hot water pumps to proper flow quantity.
- b. Adjust flow of chilled water through chiller to design value.
- c. Adjust flow of hot water through heat exchangers to design quantity.
- d. Adjust steam pressure at PRV and record at each steam heat exchanger.
- e. Observe leaving water temperatures and return water temperatures at chiller and heat exchangers. Reset to correct design temperatures.
- f. Record pump operating suction and discharge pressures. Determine final dynamic head.

3. Distribution:

- a. Balance flow to each chilled water coil and hot water coil.
- b. Record steam pressure at each steam coil.

4. Terminal Units

- a. Upon completion of flow readings and adjustments at coils, mark all settings and record following data:
 - (1) Inlet water temperatures.
 - (2) Leaving water temperatures.
- b. Observe fluid pressure drop through coil at set flow rate on call for full cooling and for full heating.
- c. Set valve in bypass to match coil flow pressure drop on full bypass.

5. Verification:

- a. Record rated and actual running amperage for each pump motor. Measure and record gpm of all pumps.
- b. Record total dynamic head for each pump.

3.5 AUTOMATIC CONTROL SYSTEM

- A. The Contractor shall set and adjust automatically operated devices to achieve specified sequence of operation.
- B. Testing organization shall verify all controls for proper calibration and list those controls requiring adjustment by temperature control system installer.

3.6 SYSTEM PERFORMANCE REPORT

- A. After the conclusion of balancing operations, make temporary installation of portable recorders and simultaneously record temperatures and humidity during summer and winter conditions at representative locations in each system.
- B. Architect / Engineer will direct all test locations.
- C. Make recordings during summer and winter for a seven-day period, continuous over a weekend, and including at least one period of operation at outside conditions within 5°F wet bulb temperature of maximum summer design condition and within 10°F dry bulb temperature of minimum winter design condition.
- D. Report of test results shall include original recording and two reproductions.

3.7 SUBMISSION OF REPORTS

- A. Fill in test results on approved forms.
- B. Submit three certified copies of required test reports to the Architect / Engineer for review.
- C. Include in report a list of instruments used and test date of calibration.
- D. Submittals shall be legibly signed by the individual(s) responsible for the accuracy of the work.

END OF SECTION 23 05 93

SECTION 23 07 00 – HVAC INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Provide and install complete insulation systems as shown on the drawings and as specified herein. Work includes, but is not limited to, the following:

- a. Contractor: Insulating of:

- (1) Hot water heating piping
- (2) Chilled water piping
- (3) Refrigerant piping

1.2 RELATED WORK

A. Specified elsewhere:

1. Division 23 - Mechanical Systems

1.3 QUALITY ASSURANCE

- A. Installations shall be by qualified personnel thoroughly trained and experienced in the skills required and completely familiar with the manufacturer's current recommended methods of installation as well as the requirements of the work.
- B. All insulation shall be applied in accordance with MICA "Commercial and Industrial Insulation Standards".

1.4 SUBMITTALS

- A. See Architectural Sections.
- B. Provide submittals for:
 1. Pipe insulation
 2. Equipment insulation
 3. Plastic insulation jacket
 4. Duct insulation

PART 2 - PRODUCTS

2.1 INSULATION

- A. Materials of insulation shall be manufactured by Johns-Manville, Schuller, Owens Corning, Knauf, Rubatex, Armstrong, Certain-Teed (acceptable manufacturers will vary depending upon material being specified herein after).

- B. Insulation shall be rigid glass fiber with fire retardant vapor barrier jacket. Insulation of fittings shall be in accordance with manufacturer's recommendations using glass fiber wrapping and formed jacket.
- C. Insulating materials and APT jackets shall conform to latest NFPA and IECC standards with flame-spread rating not to exceed 25 and smoke developed rating not to exceed 50. Vapor barrier jackets shall have a water vapor permeability rating not to exceed .02 perms when tested in accordance with ASTM Standard E-96.
- D. Flexible fire retardant elastomeric thermal insulation for use on refrigerant piping and equipment in cold piping systems (strainers, pumps, special valves) shall be manufactured by Armstrong, Schuller or Rubatek. Insulation shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less. Seal all joints with appropriate adhesive. On equipment, such as strainers, the insulation shall be installed so that those portions of the equipment which require servicing will have removable sections for access.
1. Do not use elastomeric insulation on surfaces that exceed 120 °F.
 2. Contractors shall be responsible for ensuring that use of this material in return air plenums is in full compliance with all codes and is acceptable to the authority having jurisdiction. This matter shall be resolved before shop drawings are submitted.
 3. Elastomeric insulation shall not be used on two-pipe heating / cooling.
- E. Specialties
1. All hot piping fittings and cold fittings and flanges shall be wrapped with low density glass fiber blanket insulation built up to same thickness as adjacent insulation and wired in place with 20 gauge copper clad annealed wire. Cover with plastic pre-fab jacket and seal joint and end overlaps with white nylon tape.
 2. All cold water valves, control valves, unions and other fittings requiring access shall be insulated with elastomeric foam or fiberglass of the same thickness and type as the rest of the system.
 3. Covering on all pipe fittings shall be notched on the interior of fittings and shall pass unbroken through hangers and pipe sleeves.
 4. Valves, unions, relief valves and strainers shall be insulated.
 5. Valves, unions, strainers and flanges in heating hot water piping need not be covered. Insulation shall be tapered back, neatly cemented and covered same as fittings to permit access to the joint, valve and strainer without disturbing covering.
 6. Insulation and vapor barrier on cold piping systems shall be continuous and shall prevent condensation and water problems.
 7. All piping carrying cold fluid shall be insulated with elastomeric insulation coated with two coats of paintable coating where exposed to UV light indoors. Cover elastomeric insulation with PVC jacket outdoors and where exposed to abrasions in light traffic areas indoors and outdoors.
- F. Equipment - Hot
1. Insulate equipment with operating temperature to 450 °F insulate with high density (3pcf min.) fiberglass. K-Factor 0.27 max at 75 °F, thickness as specified. Attach using 16 gauge copper clad annealed wire or weld pins and washers 12" on center.
 2. Finish for equipment heads and irregular surface where jacketed fiberglass insulation is used shall be as follows: Apply 10-10 fiberglass mesh with coat of fire retardant mastic. Apply second coat of fire retardant mastic over mesh for smooth finish.

ITEMS	THICKNESS
Heating HW Heat Exchangers 210°F	2" Fiberglass
Hot Water Air Separator	2" Fiberglass

G. Equipment - Cold

1. Insulate the following equipment with 1" thick layer of fire retardant elastomeric insulation having a flame-spread rating of less than 25 in accordance with the latest NFPA standards.

ITEMS

Chilled Water Pumps
Chilled Water Strainers

2. Insulation shall be applied with a full coating of adhesive, as recommended by the manufacturer.
3. The insulation on all pumps and strainers shall be easily removable for service.
4. Do not use elastomeric on surfaces that exceed 120°F.

H. Piping

1. Covering on all piping shall pass unbroken through hangers and pipe sleeves with insulation protection saddles. Molded fiberglass saddles shall be directly adhered to insulation jacket using an appropriate glue.
 - a. Acceptable Manufacturers:
 - (1) Buckaroos, Inc.
 - (2) Pipesield, Inc.
 - (3) B-Line Systems, Inc.
 - (4) Centerline
2. Where section of water pipe 2-1/2" and larger passes through hangers, provide fiberglass plug inserts to prevent crushing of insulation. Size of pipe shall indicate number of plug to insert, i.e., 2" = 2 plugs, 4" = 4 plugs, etc. Provide 7¼ lbs. density insulation on pipe 2" and smaller extending 6" beyond ends of metal jacket. Insulation shall be of same thickness as specified material. Vapor barrier shall not be damaged.
 - a. Acceptable Manufacturers:
 - (1) Buckaroos, Inc.
 - (2) Pipesield, Inc.
 - (3) B-Line Systems, Inc.
 - (4) Centerline
3. All laps in jacket shall be on top of horizontal pipes and toward the wall in vertical pipes and shall be sealed with staples and flame retardant adhesive. Laps shall be a minimum of 3" at end joints and 1-1/2" on longitudinal joints.
4. Insulate the following piping as described below, or as noted on drawings:
5. Apply 3-1/2 lb minimum density, 0.27 maximum k factor / inch fiberglass pipe insulation on piping systems.
6. Apply 3-1/2 lb minimum density, 0.27 maximum k factor / inch fiberglass pipe insulation on piping systems in accordance with the following:

HWSH - Hot Water Supply Heating
 HWRH - Hot Water Return Heating
 HWRRH - Hot Water Reverse Return Heating

PIPE SIZE	INSULATION THICKNESS
1-1/2" and less	1-1/2"
2" and greater	2"

CHWS - Chilled Water Supply
 CHWR - Chilled Water Return
 CHWRR - Chilled Water Reverse Return

PIPE SIZE	INSULATION THICKNESS
All Sizes	1-1/2"

- 7. Apply elastomeric foam pipe insulation on piping systems in accordance with the following maximum k factor 0.27 / inch:

Refrigerant piping and all VRF equipment piping
 Cold control valves
 Drain lines from cooling equipment

PIPE SIZE	INSULATION THICKNESS
All	1-1/2"

- 8. Apply elastomeric foam pipe insulation on piping system in accord with the following maximum k factor 0.27 / inch (can be used in lieu of fiberglass if allowed by Code):

CHWS, CHWR

PIPE SIZE	INSULATION THICKNESS
All Sizes	1-1/2"

- 9. Seal ends of insulation and inside surface of insulation to pipe every 21' on straight runs, at each side of fittings and valves and at all equipment.
- 10. Insulation on piping in concealed locations may use permanently treated (not salt treatment) flame-retardant jacket. Jackets on hot lines in concealed locations may be stapled without use of adhesive as specified above.

2.2 MINERAL-FIBER INSULATION INSTALLATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

- 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
- 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
- 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
- a. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 - b. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

- b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

PART 3 - EXECUTION

3.1 INSULATING PIPING

- A. Provide all pipe covering, thermal insulation, protective jacketing, saddles, shields and plugs for the systems in their contracts as specified. Work shall be performed by skilled mechanics regularly engaged in the application of pipe insulation.
- B. No insulation shall be applied until all pressure tests have been successfully completed.

3.2 PIPING OUTDOORS

- A. Pipe insulation installed outdoors shall be protected by:
 1. Weathertight aluminum jacketing
- B. Foam pipe insulation installed outdoors shall be protected by aluminum jacketing.

3.3 DUCT INSULATION

- A. Supply, outdoor, relief air (between dampers and outdoors) and exhaust air (between dampers and outdoors) duct insulation shall be the following:
 - 1. Mineral Fiber Blanket: 1-1/2 inches thick, 1.0 lb / cu. ft. nominal density.
- B. Access doors and fire dampers shall be insulated with the following:
 - 1. Mineral Fiber Blanket: 1-1/2 inches thick, 1.0 lb / cu. ft. nominal density.
- C. Exposed ductwork in finished areas shall be insulated with the following:
 - 1. Mineral Fiber Board Insulation: 1-1/2 inches thick, 2 lb / cu. ft. nominal density.
 - 2. Board insulation to be painted shall have all service jacket.
 - 3. Board insulation not to be painted shall have foil jacket.
 - 4. Supply ductwork from heating only make-up air units does not require duct insulation. The discharge air temperature shall not exceed in a difference of 15 degrees F compared to the surrounding space temperature.
- D. Finish areas include storage rooms, server rooms and bus storage.

END OF SECTION 23 07 00

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
 - 2. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. MS/TP: Master slave/token passing.
- E. PC: Personal computer.
- F. PID: Proportional plus integral plus derivative.
- G. RTD: Resistance temperature detector.
- H. IP: Internet protocol.

1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.
 - i. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - j. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - k. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - l. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - m. Carbon Dioxide: Plus or minus 50 ppm.
 - n. Electrical: Plus or minus 5 percent of reading.

1.5 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.

3. Wiring Diagrams: Power, signal, and control wiring.
 4. Details of control panel faces, including controls, instruments, and labeling.
 5. Written description of sequence of operation.
 6. Schedule of dampers including size, leakage, and flow characteristics.
 7. Schedule of valves including flow characteristics.
 8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.
- C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- D. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.
- E. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- F. Samples for Verification: For each color required, of each type of thermostat or sensor cover.
- G. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.
 5. Software license required by and installed for DDC workstations and control systems.
- H. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- I. Qualification Data: For Installer and manufacturer.
- J. Field quality-control test reports.

- K. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 5. Calibration records and list of set points.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE 135 for DDC system components.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where the equipment manufacturer's factory packaged controls are capable of providing the BAS interface specified, the equipment manufacturer's controls may be utilized. Where controls are provided by other than the equipment manufacturer, arrange for shipping of required devices to equipment manufacturer for factory mounting as required for proper equipment function.
- B. System Software: Update to latest version of software at Project completion.

1.8 COORDINATION

- A. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- F. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

- G. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- H. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replacement Materials: One replacement for each unique valve motor, controller, thermostat, positioning relay.
 - 2. Maintenance Materials: Five thermostat adjusting key(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

- A. Manufacturers:
 - 1. Alpha Controls
 - 2. ECSi
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation shall permit interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- D. Expand existing temperature control system software database to include all new controlled mechanical equipment. Control system shall be accessible via campus Ethernet network.

2.3 DDC EQUIPMENT

- A. Operator Workstation and Printer: Existing operator workstation and printer are to be retained.
1. Application Software: Modify existing temperature control software as necessary to provide the level of control specified herein for new and existing equipment and systems.
 - a. I/O capability from operator station.
 - b. System security for each operator via software password and access levels.
 - c. Automatic system diagnostics; monitor system and report failures.
 - d. Database creation and support.
 - e. Automatic and manual database save and restore.
 - f. Dynamic color graphic displays with up to 10 screen displays at once.
 - g. Custom graphics generation and graphics library of HVAC equipment and symbols.
 - h. Alarm processing, messages, and reactions.
 - i. Trend logs retrievable in spreadsheets and database programs.
 - j. Alarm and event processing.
 - k. Object and property status and control.
 - l. Automatic restart of field equipment on restoration of power.
 - m. Data collection, reports, and logs. Include standard reports for the following:
 - 1) Current values of all objects.
 - 2) Current alarm summary.
 - 3) Disabled objects.
 - 4) Alarm lockout objects.
 - 5) Logs.
 - n. Custom report development.
 - o. Utility and weather reports.
 - p. Workstation application editors for controllers and schedules.
 - q. Maintenance management.
 2. Custom Application Software:
 - a. English language oriented.
 - b. Full-screen character editor/programming environment.
 - c. Allow development of independently executing program modules with debugging/simulation capability.
 - d. Support conditional statements.
 - e. Support floating-point arithmetic with mathematic functions.
 - f. Contains predefined time variables.
- B. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:
1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
 2. Processor: Core 2, 2.0 GHz.
 3. Random-Access Memory: 1.0 GB.
 4. Graphics: Video adapter, minimum 1024 x 768 pixels, 64-MB video memory.
 5. Monitor: 15 inches, LCD color.

6. Keyboard: QWERTY 105 keys in ergonomic shape.
 7. Hard-Disk Drive: 80 Gb.
 8. CD-ROM Read/Write Drive: 48x24x48.
 9. Pointing Device: Touch pad or other internal device.
- C. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 3. Standard Application Programs:
 - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
 - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - d. Remote communications.
 - e. Maintenance management.
 - f. Units of Measure: Inch-pound and SI (metric).
 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
 6. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
- D. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.

- c. Monitoring, controlling, or addressing data points.
 3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
 5. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
- E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 1. Binary Inputs: Allow monitoring of on-off signals without external power.
 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 1. Minimum dielectric strength of 1000 V.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
 1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.
5. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
6. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.5 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.6 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. Ebtron, Inc.
 - c. Heat-Timer Corporation.
 - d. I.T.M. Instruments Inc.
 - e. MAMAC Systems, Inc.
 - f. RDF Corporation.
 2. Accuracy: Plus or minus 0.5 deg F at calibration point.
 3. Wire: Twisted, shielded-pair cable.

4. Insertion Elements in Ducts: Single point; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
 5. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft..
 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Exposed.
 - c. Thermometer: Red-reading glass.
 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- C. RTDs and Transmitters:
1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. MAMAC Systems, Inc.
 - c. RDF Corporation.
 2. Accuracy: Plus or minus 0.2 percent at calibration point.
 3. Wire: Twisted, shielded-pair cable.
 4. Insertion Elements in Ducts: Single point, 8 inches or 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
 5. Averaging Elements in Ducts: 48 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
 6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Exposed.
 - c. Thermometer: Red-reading glass.
 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- D. Humidity Sensors: Bulk polymer sensor element.
1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. TCS/Basys Controls.
 - f. Vaisala.
 2. Accuracy: 5 percent full range with linear output.

3. Room Sensor Range: 20 to 80 percent relative humidity.
 4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Exposed.
 - b. Set-Point Indication: Exposed.
 5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
 6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.
 7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
- E. Pressure Transmitters/Transducers:
1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. TCS/Basys Controls.
 - f. Vaisala.
 2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0- to 0.25-inch wg.
 - d. Duct Static-Pressure Range: 0- to 5-inch wg.
 3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
 4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
 5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
 6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.
- F. Room Sensor Cover Construction: Manufacturer's standard locking covers.
1. Set-Point Adjustment: Exposed.
 2. Set-Point Indication: Exposed.
- G. Room sensor accessories include the following:
1. Insulating Bases: For sensors located on exterior walls.
 2. Adjusting Key: As required for calibration and cover screws.
- H. Photocell, see Section 23 0993 for description.

2.7 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
 - 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. I.T.M. Instruments Inc.

2.8 GAS DETECTION EQUIPMENT

- A. Manufacturers:
 - 1. B. W. Technologies.
 - 2. CEA Instruments, Inc.
 - 3. Ebtron, Inc.
 - 4. Gems Sensors Inc.
 - 5. Greystone Energy Systems Inc.
 - 6. Honeywell International Inc.; Home & Building Control.
 - 7. INTEC Controls, Inc.
 - 8. I.T.M. Instruments Inc.
 - 9. MSA Canada Inc.
 - 10. QEL/Quatrosense Environmental Limited.
 - 11. Sauter Controls Corporation.
 - 12. Sensidyne, Inc.

13. TSI Incorporated.
 14. Vaisala.
 15. Vulcain Inc.
- B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- C. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- D. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.9 THERMOSTATS

- A. Manufacturers:
1. Same as Direct Digital Controller Manufacturer.
- B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
1. Label switches "FAN ON-OFF".
 2. Mount on single electric switch box.
- C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
- D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 2. Selector Switch: Integral, manual on-off-auto.
- E. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
1. Bulbs in water lines with separate wells of same material as bulb.
 2. Bulbs in air ducts with flanges and shields.
 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

- F. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:
 - 1. Reset: Manual.
 - 2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- G. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- H. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- I. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- J. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- K. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.
- L. Thermostats shall be provided by the Contractor and compatible with the BAS. Night setback and thermostat settings shall be controlled by BAS.

2.10 HUMIDISTATS

- A. Manufacturers:
 - 1. MAMAC Systems, Inc.
 - 2. ROTRONIC Instrument Corp.
- B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.11 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. X lbf and breakaway torque of 300 in. X lbf.
 4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. X lbf.
 5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. X lbf and breakaway torque of 300 in. X lbf.
 6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. X lbf.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Manufacturers:
 - a. Schneider Electric.
 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
 4. Coupling: V-bolt and V-shaped, toothed cradle.
 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 7. Power Requirements (Two-Position Spring Return): 24-V ac.
 8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 10. Temperature Rating: Minus 22 to plus 122 deg F.
 11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
 12. Run Time: 12 seconds open, 5 seconds closed.
- 2.12 CONTROL VALVES
- A. Manufacturers:
1. Schneider Electric.
 2. Siemens.
 3. Honeywell.

- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Hydronic system globe valves shall have the following characteristics:
1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
 2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
 3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
 - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
 - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
 4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:
 - a. Two Position: Line size.
 - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
 - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
 5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- D. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
1. Body Style: Wafer.
 2. Disc Type: Aluminum bronze.
 3. Sizing: 1-psig maximum pressure drop at design flow rate.

2.13 DAMPERS

- A. Manufacturers:
1. Air Balance Inc.
 2. Don Park Inc.; Autodamp Div.
 3. TAMCO (T. A. Morrison & Co. Inc.).
 4. United Enertech Corp.
 5. Vent Products Company, Inc.

- B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
 - 1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 - 2. Operating Temperature Range: From minus 40 to plus 200 deg F.
 - 3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
 - 4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. X lbf; when tested according to AMCA 500D.

2.14 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install guards on thermostats in the following locations:
 - 1. Entrances.
 - 2. Public areas.
 - 3. Where indicated.

- E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- I. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 6. Test each system for compliance with sequence of operation.
 7. Test software and hardware interlocks.
- C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check installation of air supply for each instrument.
 6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 8. Check temperature instruments and material and length of sensing elements.
 9. Check control valves. Verify that they are in correct direction.
 10. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

- A. Calibrating and Adjusting:
1. Calibrate instruments.
 2. Make three-point calibration test for both linearity and accuracy for each analog instrument.

3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
 5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
 6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
 9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 10. Provide diagnostic and test instruments for calibration and adjustment of system.
 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. 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 three visits to Project during other than normal occupancy hours for this purpose.
- 3.6 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 09 00

SECTION 23 09 93 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. Related Sections include the following:
 - 1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

- A. DDC: Direct digital control.

1.4 CONTROLLED SYSTEMS

- A. This system is intended to provide automatic control of the following systems and equipment. Control systems shall be complete with all items of labor and material necessary to give specified performance.
 - 1. All radiation
 - 2. All unit heaters
 - 3. All exhaust fans
 - 4. Hot water heating system pumps and boilers
 - 5. All air handling units
 - 6. VAV boxes
 - 7. VRF system

1.5 ROOF MOUNTED AIR HANDLING UNITS

- A. The AHU's shall come complete with VFD provided and installed by Contractor. The Contractor shall provide and field install DDC controllers. The variable volume air handling unit consists of a mixed air section with minimum outdoor air (two-position), outdoor air (modulating), exhaust air and return air dampers, pre-filter, final filter, glycol heating coil, chilled water cooling coil, supply fans with variable frequency drives. The unit is DDC controlled using electric actuation.
- B. The air handling unit is scheduled for automatic operation on a scheduled basis.

- C. Warm-Up Mode - The supply fans start. The mixing dampers are positioned for 100% return air, the heating coil valve opens and the cooling coil valve remains closed. If time reaches the latest start time during the Warm-Up mode, the outdoor air damper opens to its minimum position. The system is prevented from entering the Warm-Up mode more than once per day.
- D. Cool-Down Mode - The supply fans start. The cooling coil valve and the mixing dampers modulate to maintain the supply air temperature set point. When the outdoor air dry bulb temperature is above the economizer changeover value, the mixing dampers position for 100% return air. If time reaches the latest start time during the Cool-Down mode, the outdoor air damper opens to its minimum position or is controlled in economizer operation. The system is prevented from entering the Cool-Down mode more than once per day.
- E. When the outside air dry bulb temperature is below the economizer changeover value, the heating section, cooling coil valve and mixing dampers modulate in sequence without overlap to maintain the supply air temperature set point with a low limit of 48 degrees F (9 degrees C) at the mixed air sensor. The mixing dampers ramp open slowly to minimize overshooting.
- F. When the outside air dry bulb temperature is above the economizer changeover value, the mixing dampers are placed in the minimum outdoor air position. The heating and cooling coil valves stage in sequence without overlap to maintain the supply air temperature set point.
- G. Supply Duct and Building Pressurization Control - The supply fan variable frequency drive modulate to maintain a constant duct static pressure of 1.5 inches of water as sensed at least 2/3 of the distance downstream of the supply fans in either the longest or most critical duct run. The return fan variable frequency drive modulates to maintain the differential CFM set point to maintain a positive building pressure differential. The supply CFM to return CFM differential set point is 0% if the OA damper is closed. Upon shutdown of the air handling system, the supply and return fans variable frequency drives are stopped and the speed signal goes to zero speed.
- H. Minimum OA Control - Outside air flowrate shall be monitored and outside air intake dampers controlled to maintain specified minimum outside air quantity at all times. The rooftop unit shall have a minimum OA airflow during occupied hours as listed on the schedule. The OA damper shall modulate open to satisfy the space CO₂ setpoints.
- I. Discharge high static and suction low static cutouts on the supply fan, smoke detectors in the supply and return air streams, and supply and relief / exhaust fans VFD fault alarms de-energize the supply and relief / exhaust fans upon activation. When the OAT is less than 45 degrees F (7 degrees C), the heating coil valve modulates to maintain the mixed air temperature at 54 degrees F (7 degrees C). All other dampers and valves position to their normal position after the fans are de-energized.
- J. A low temperature detector in the discharge of the heating coil de-energizes the supply fan when temperatures below 38 degrees F (3 degrees C) are sensed. The heating coil valve modulates to maintain the mixed air temperature at 54 degrees F (7 degrees C). All other dampers and valves position to their normal position after the fans are de-energized.
- K. Current switches are installed on the load side of the supply and relief / exhaust fans VFDs. The DDC system uses the switches to confirm the fans are in the desired state (i.e. on or off) and generates an alarm if status deviates from DDC start/stop control. The DDC system generates a VFD trouble alarm independent from the fan status.

- L. During economizer free cooling operation as the need for additional outside air, the RTU OA damper shall modulate open and relief fan shall energize to maintain space differential pressure.

1.6 HOT WATER SYSTEM AND VARIABLE SPEED HOT WATER PUMPS

- A. Heating Control - The heating system enable point is controlled either manually by the operator or by a program function (i.e., Time-Of-Day). If the heating system enable point is on, the lead hot water pump starts.
- B. The hot water supply set point is reset based on outdoor air temperature. When the outdoor air temperature is 0 degrees F (-18 degrees C), the set point is 180 degrees F (82 degrees C) and when the outdoor air temperature is 60 degrees F (16 degrees C), the set point is 120 degrees F (49 degrees C).
- C. Pump Alternation - Pumps alternate to equalize equipment runtime. Selection of the lead and second pump is evaluated on a weekly basis. The pump with the least runtime is the lead. The remaining pump is second. If the lead pump fails, an alarm is generated and the second pump starts.
- D. Heating Water Pump Speed Control - The variable frequency drive modulates pump speed to maintain system differential pressure of 20 PSI (adjustable) as sensed near the end of the secondary piping run. If the system differential pressure is below set point and the lead pump is at 100% speed for a time interval of 15 minutes, the lag pump starts. With both pumps on, the variable frequency drives are modulated in unison to maintain system differential pressure. If the system differential is at set point and both pumps are on and at 45% speed for a time interval of 15 minutes the lag pump is stopped.
- E. The DDC system uses current switches to confirm the pumps are in the desired state (i.e. on or off) and generates an alarm if status deviates from DDC start/stop control.

1.7 VAV BOXES WITH REHEAT COILS - DDC OPERATORS

- A. The variable volume (VAV) terminal unit is controlled independent of system pressure fluctuations by an application specific DDC controller using electric actuation. The space served by the VAV terminal unit is controlled in Occupied and Unoccupied modes as follows.
- B. Occupied - The VAV terminal unit is controlled within user defined maximum and minimum supply air volume settings. The controller monitors the room temperature sensor and air velocity sensor and modulates the supply air damper in sequence with the reheat valve to maintain the room temperature at set point. Supply air volume remains at minimum when HW reheat valve is modulated.
- C. Unoccupied - The terminal unit is controlled using the night set point. The controller may reset to the Occupied mode for a predetermined time period upon a signal from the control system or manually at the room sensor.

1.8 MISCELLANEOUS CONTROLS

- A. Cabinet Unit Heaters: Monitor space temperature and modulate hot water control valve as necessary to maintain setpoint temperature.

- B. Boiler Controls: Boilers shall come complete with their factory control package. Provide boiler system enable from BAS.
- C. Exhaust Fans: Power Roof Ventilators: Provide scheduled start/stop, fan run status, and speed control signals. Provide VFD's (where noted) to EC for installation and wiring.
- D. Split System: Unit shall come complete with factory control package and room thermostat. Provide low voltage control wiring and connect unit alarm contacts to BAS for monitoring.
- E. Fin Tube Controls: Monitor space temperature and modulate hot water control valve as necessary to maintain setpoint temperature.
- F. Misc. Devices: Provide and install outside air temperature and humidity sensors. Provide and install building static pressure sensor comparing the outside conditions to a common area in the building.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 09 93

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410a:
 - 1. Suction Lines for Air-Conditioning Applications: 320 psig.
 - 2. Suction Lines for Heat-Pump Applications: 520 psig.
 - 3. Hot-Gas and Liquid Lines: 520 psig.

1.3 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.5 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg F.
- B. Packed-Angle Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze.
 - 2. Packing: Molded stem, back seating, and replaceable under pressure.
 - 3. Operator: Rising stem.
 - 4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
 - 5. Seal Cap: Forged-brass or valox hex cap.
 - 6. End Connections: Socket, union, threaded, or flanged.
 - 7. Working Pressure Rating: 500 psig.

8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Safety Relief Valves: Provided by manufacturer.

F. Thermostatic Expansion Valves: Provided by manufacturer.

G. Moisture/Liquid Indicators: Provided by manufacturer.

H. Replaceable-Core Filter Dryers: Provided by manufacturer.

I. Permanent Filter Dryers: Provided by manufacturer.

J. Liquid Accumulators: Provided by manufacturer.

2.3 REFRIGERANTS

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

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

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in liquid and discharge lines of compressor.
- B. Install service valves for gage taps at strainers if they are not an integral part of strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- G. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- H. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected.
- I. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- J. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.

- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install traps and double risers to entrain oil in vertical runs.
 - 3. Liquid lines may be installed level.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

- A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BA_g, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

- a. Fill system with nitrogen to the required test pressure.
- b. System shall maintain test pressure at the manifold gage throughout duration of test.
- c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
- d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
 1. Install core in filter dryers after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Louvers.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Lindab Inc.
 2. McGill AirFlow LLC.
 3. SEMCO Incorporated.
 4. Sheet Metal Connectors, Inc.
 5. Lapine Metal Products
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Cover insulation with polyester film complying with UL 181, Class 1.

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G60.
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 2. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 4 inches.
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
10. VOC: Maximum 395 g/L.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

2.7 LOUVERS

- A. Provide and install extruded aluminum louvers in walls as shown on drawings and as specified herein.
- B. Intake louvers shall be 4" deep double hook design arranged to permit bottom of duct to hook over bottom blade for drainage to outside.
- C. Louvers in other walls shall have wall flange on sides, top and bottom.
- D. All louvers shall be constructed of minimum .081 extrusions, with reinforcing bosses and bars as required.
- E. Furnish 5/8" mesh removable bird screens on inside of all louvers, constructed of .063 wire with extruded frames.
- F. Louvers shall have color anodized finish. Final louver finish shall be selected by Architect/Engineer at shop drawing review stage. Submit color samples with shop drawings.
- G. All louvers shall have AMCA rating and label. The manufacturer shall furnish air pressure loss and water penetration data with all submittals.
- H. Acceptable manufacturers: Air Balance Inc., Chicago, Illinois; The Aiolite Co., Marietta, Ohio; American Warming and Vent Co., Inc., Toledo, Ohio; Arrow United, Long Island City, New York; and Vent Products Co., Inc., Chicago, Illinois. Ruskin.
- I. Provide insulated panels to blank off unused portion(s) of louvers not used for ducted connections:
 - 1. Panels shall be insulated with 1" thick rigid closed cell foam enclosed in 22 gage (minimum) sheet metal.
 - 2. Prime panels with rust-resistant paint, color selected by Architect.
 - 3. Panels shall be anodized aluminum in color to match louver.
- J. Forward shop drawing submittals to the Architect/Engineer for review.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. All ducts shall be of size indicated on the drawings. In no case shall the indicated duct size be changed without written approval of the Architect / Engineer.
- C. Duct sizes shown on drawings are met inside area. Where duct lining is specified, increase duct sizes to allow for lining.

- D. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- E. Install round and flat-oval ducts in maximum practical lengths.
- F. Install ducts with fewest possible joints.
- G. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- H. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- J. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- K. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- L. Where ducts pass through non-fire rated interior partitions, seal around duct with non-combustible material.
- M. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- N. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- O. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.
- F. Support all horizontal ducts up to 46" wide with field punched steel strap hangers, sized per SMACNA, placed down side, turned under bottom of ducts and securely fastened to the building construction in an approved manner. Ducts from 47" up to 70" wide shall have 1.50" x 1.50" x 3/16" angle iron trapeze hangers with 3/8"

diameter rods attached to building construction. Ducts from 71" up to 118" wide shall have 2.50" x 2" x 5/16" angle iron trapeze hangers with ½" diameter rods attached to building construction. Space horizontal duct supports not more than 8'-0" apart. All hangers and stiffeners shall be galvanized steel.

- G. No piping, conduit, ceiling supports or any other building element shall be suspended from duct supports.
- H. Carefully check the arrangement of ducts and dimensions of all working spaces at the building so that there will be no interference with the running of ducts. Carefully lay out all openings in floors and walls.
- I. Increase duct sizes gradually, not exceeding 15 divergence or convergence in duct runs.
- J. Where plenum-type takeoffs or runouts are shown and at all flex duct connections to rectangular ducts, the area of opening into main duct shall be a minimum of 150% of branch duct area.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

- A. Supply Ducts:
 1. Ducts Connected to Fan Coil Units, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 2. Ducts Connected to Constant-Volume Air-Handling Units:

- a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- B. Return Ducts:
1. Ducts Connected to Fan Coil Units, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- C. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 2. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
 - a. Exposed to View: Type 304, 14 gauge, stainless-steel sheet, No. 4 finish.
 - b. Concealed: Type 304, stainless-steel sheet, No. 2D finish or 14 gauge carbon steel sheet.
 - c. Welded seams and joints.
 - d. Pressure Class: Positive or negative 3-inch wg.
 - e. SMACNA Leakage Class: 3.
- D. Liner:
1. Return Air Ducts: Fibrous glass, Type I, 1 inch thick.
 2. Exhaust / Relief Ducts (Where Shown on the Drawings): Fibrous glass, Type I, 1 inch thick.
- E. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

- b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or welded.

END OF SECTION 23 31 13

SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Flange connectors.
6. Turning vanes.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Flexible ducts.
10. Duct accessory hardware.

B. Related Sections:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

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

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.

- d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. American Warming and Ventilating; a division of Mestek, Inc.
 - 3. Cesco Products; a division of Mestek, Inc.
 - 4. Duro Dyne Inc.
 - 5. Greenheck Fan Corporation.
 - 6. Lloyd Industries, Inc.
 - 7. Nailor Industries Inc.
 - 8. NCA Manufacturing, Inc.
 - 9. Pottorff; a division of PCI Industries, Inc.
 - 10. Ruskin Company.
 - 11. SEMCO Incorporated.
 - 12. Vent Products Company, Inc.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 1-inch wg.
- E. Frame: galvanized sheet steel or extruded aluminum with welded corners.
- F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Extruded vinyl, mechanically locked or neoprene, mechanically locked.
- I. Return Spring: Adjustable tension.
- J. Bearings: Steel ball or synthetic pivot bushings.
- K. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.

5. Bird screen.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Pottorff; a division of PCI Industries, Inc.
 - h. Ruskin Company.
 - i. Trox USA Inc.
 - j. Vent Products Company, Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Bearings:
 - a. Oil-impregnated bronze or molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

2.4 FIRE DAMPERS

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

1. Air Balance Inc.; a division of Mestek, Inc.

2. Arrow United Industries; a division of Mestek, Inc.
 3. Cesco Products; a division of Mestek, Inc.
 4. Greenheck Fan Corporation.
 5. McGill AirFlow LLC.
 6. METALAIRE, Inc.
 7. Nailor Industries Inc.
 8. NCA Manufacturing, Inc.
 9. PHL, Inc.
 10. Pottorff; a division of PCI Industries, Inc.
 11. Prefco; Perfect Air Control, Inc.
 12. Ruskin Company.
 13. Vent Products Company, Inc.
 14. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
 15. Limited Enertech.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
- D. Fire Rating: 3 hours.
- E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- 2.5 FLANGE CONNECTORS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Nexus PDQ; Division of Shilco Holdings Inc.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.6 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.7 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pottorff; a division of PCI Industries, Inc.
 - 2. Ventfabrics, Inc.
 - 3. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.

2.8 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.
 - 3. Ductmate Industries, Inc.

4. Flexmaster U.S.A., Inc.
5. Greenheck Fan Corporation.
6. McGill AirFlow LLC.
7. Nailor Industries Inc.
8. Pottorff; a division of PCI Industries, Inc.
9. Ventfabrics, Inc.
10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.9 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Flame Gard, Inc.
 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon or 0.0428-inch stainless steel to match duct material.
- D. Fasteners: Carbon or stainless steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.10 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.11 FLEXIBLE DUCTS

- A. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.

B. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.13 DUCT SILENCERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Dynasonic.
 2. Industrial Noise Control, Inc.
 3. McGill AirFlow LLC.
 4. Ruskin Company.
 5. Commercial Acoustics.
 6. Vibro-Acoustics.
- B. General Requirements:
 1. Factory fabricated.
 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- C. Shape:
 1. Rectangular straight with splitters or baffles.
 2. Round straight with center bodies or pods.
 3. Rectangular elbow with splitters or baffles.
 4. Round elbow with center bodies or pods.
 5. Rectangular transitional with splitters or baffles.
- D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G60, galvanized sheet steel, 0.040 inch thick.
- E. Round Silencer Outer Casing: ASTM A 653/A 653M, G60, galvanized sheet steel.
 1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
 2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
 3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.052 inch thick.

- F. Inner Casing and Baffles: ASTM A 653/A 653M, G60 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch- diameter perforations.
- G. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- H. Principal Sound-Absorbing Mechanism:
 - 1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
 - 2. Dissipative type with fill material.
 - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression.
 - b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
 - 3. Lining: Fiberglas cloth.
- I. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
 - 1. Flange connections.
 - 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 - 3. Reinforcement: Cross or trapeze angles for rigid suspension.
- J. Accessories:
 - 1. Factory-installed end caps to prevent contamination during shipping.
 - 2. Removable splitters.
 - 3. Airflow measuring devices.
- K. Source Quality Control: Test according to ASTM E 477.
 - 1. Testing to be witnessed by Architect.
 - 2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
 - 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.
- L. Capacities and Characteristics:
 - 1. Configuration: Straight.
 - 2. Shape: Rectangular.
 - 3. Attenuation Mechanism: Acoustical glass fiber with protective film liner.
 - 4. Maximum Pressure Drop: 0.35-inch wg.
 - 5. Casing:
 - a. Attenuation: Standard.
 - b. Outer Material: Galvanized steel.

- c. Inner Material: Galvanized steel.
- 6. Length: See plans.
- 7. Face Dimension: See plans.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- E. Where damper operators occur above non-accessible ceilings, extend operator down to ceiling and terminate with a concealed damper regulator.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated.
- H. Install fire dampers according to UL listing.
- I. Install opposed-blade volume dampers in each and every zone duct downstream of multi-zone units.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream and downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from all manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.

8. Upstream and downstream from turning vanes.
 9. Control devices requiring inspection.
 10. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.
- L. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- M. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- N. Install flexible connectors to connect ducts to equipment.
- O. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- P. Connect diffusers boots to ducts directly or with maximum 48 inch lengths of flexible duct clamped or strapped in place.
- Q. Connect flexible ducts to metal ducts with draw bands.
- R. Install duct test holes where required for testing and balancing purposes.
- S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
- T. Provide airtight and grease tight cleanout doors in kitchen hood exhaust ductwork. Provide at each connection in horizontal ducts, at each elbow, every 20' in straight duct and above every floor in vertical risers.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.
 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 34 23 – HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal roof ventilators and upblast fans.
 - 2. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

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

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Carnes Company HVAC.
 - 3. Greenheck.
 - 4. Loren Cook Company.
 - 5. Pennbarry.
- D. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- E. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- F. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- G. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Fan and motor isolated from exhaust airstream.
- H. Accessories:
 - 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
- I. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange.
 - 2. Overall Height: 12 inches.
 - 3. Pitch Mounting: Manufacture curb for roof slope.
 - 4. Metal Liner: Galvanized steel.

2.2 PROPELLER FANS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Carnes Company HVAC.
 - 3. Greenheck.
 - 4. Loren Cook Company.
 - 5. Pennbarry.
- D. Description: Direct-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.
- E. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
- F. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
- G. Accessories:
 - 1. Motorized Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings and electric actuator wired to close when fan stops.
 - 2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
 - 3. Wall Sleeve: Galvanized steel to match fan and accessory size.
 - 4. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.3 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- B. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 9. Shut unit down and reconnect automatic temperature-control operators.
 - 10. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 23 34 23

SECTION 23 37 13 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Continuous tubular diffusers.
4. Adjustable bar registers and grilles.
5. Fixed face grilles.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 5. Duct access panels.
- E. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Hart & Cooley Inc.
 - e. Krueger.
 - f. METALAIRE, Inc.
 - g. Nailor Industries Inc.
 - h. Price Industries.
 - i. Titus.
 - j. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: Baked enamel, color selected by Architect.
5. Face Size: 24 by 24 inches.
6. Face Style: Four cone.
7. Mounting: Surface and T-bar.
8. Pattern: Fixed.
9. Dampers: Opposed blade.
10. Accessories:
 - a. Plaster ring.

B. Louver Face Diffuser:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. METALAIRE, Inc.
 - e. Nailor Industries Inc.

- f. Price Industries.
 - g. Titus.
 - h. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
 3. Material: Aluminum.
 4. Finish: Baked enamel, color selected by Architect.
 5. Face Size: 24 by 24 inches.
 6. Mounting: Surface and T-bar.
 7. Pattern: Four-way core style.
 8. Dampers: Opposed blade.
 9. Accessories:
 - a. Square to round neck adaptor.
 - b. Equalizing grid.
 - c. Plaster ring.

2.2 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Dayus Register & Grille Inc.
 - e. Hart & Cooley Inc.
 - f. Krueger.
 - g. METALAIRE, Inc.
 - h. Nailor Industries Inc.
 - i. Price Industries.
 - j. Titus.
 - k. Tuttle & Bailey.
2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Face Blade Arrangement: Vertical spaced 3/4 inch apart.
5. Core Construction: Integral.
6. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.
7. Frame: 1-1/4 inches wide.
8. Mounting Frame: See drawings.
9. Mounting: Countersunk screw.
10. Damper Type: Adjustable opposed blade.
11. Accessories:
 - a. Front-blade gang operator.

B. Adjustable Bar Grille:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Dayus Register & Grille Inc.
 - e. Hart & Cooley Inc.
 - f. Krueger.
 - g. METALAIRE, Inc.
 - h. Nailor Industries Inc.
 - i. Price Industries.
 - j. Titus.
 - k. Tuttle & Bailey.
2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Face Blade Arrangement: Vertical spaced 3/4 inch apart.
5. Core Construction: Integral.
6. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.
7. Frame: 1-1/4 inches wide.
8. Mounting Frame: See drawing.
9. Mounting: Countersunk screw.

C. Fixed Face Grille:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. A-J Manufacturing Co., Inc.
 - b. Anemostat Products; a Mestek company.
 - c. Carnes.
 - d. Dayus Register & Grille Inc.
 - e. Hart & Cooley Inc.
 - f. Krueger.
 - g. Nailor Industries Inc.
 - h. Price Industries.
 - i. Titus.
 - j. Tuttle & Bailey.
2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Removable.
6. Frame: 1-1/4 inches wide.
7. Mounting Frame: Filter.
8. Mounting: Countersunk screw and Lay in.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 37 23 – HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Contractor: Work includes:
 - a. Roof hoods.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.
- B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
 1. Temperature Change (Range): 120 deg F, ambient; material surfaces.
- D. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1-2004.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.5 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.
- E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 - 1. Use types and sizes to suit unit installation conditions.

2.2 FABRICATION, GENERAL

- A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

2.3 ROOF HOODS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme Engineering & Mfg. Corporation.
 - 2. Carnes.
 - 3. Greenheck Fan Corporation.

4. Loren Cook Company.
 5. Pennbarry
- B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.
- C. Materials: Aluminum sheet, minimum 0.063-inch- thick base and 0.050-inch- thick hood; suitably reinforced.
- D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
1. Configuration: Self-flashing without a cant strip with mounting flange.
 2. Overall Height: 12 inches.
- E. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Install gravity ventilators with clearances for service and maintenance.
- C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.
- E. Label gravity ventilators according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- G. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

END OF SECTION 23 37 23

SECTION 23 52 16 – CONDENSING BOILERS

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Contractor: Work includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.2 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details.

- a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
- b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

G. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.3 QUALITY ASSURANCE

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

- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fire-Tube Condensing Boilers:
 - a. Leakage and Materials: 10 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers shall verify boilers can be properly installed in available space with proper service access.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lochinvar.
 - 2. Weil McLain.
 - 3. Aerco KC Series.
 - 4. Raypak X-Fyre H7-850.
 - 5. LAARS Neotherm.
 - 6. RBI Futura Fusion.
 - 7. Apex.
 - 8. Keystone.

2.2 HOT WATER BOILER BURNER UNIT (CONDENSING GAS FIRED)

A. Boiler Design

1. Boiler shall be a compact, single-pass, vertical down-fired Firetube type, with 316 Ti stainless steel tubes, tube sheets, and combustion chamber. The boiler pressure vessel shall be completely insulated with a minimum of 2" of insulation and shall be encased in a sheet metal cabinet with powder coated finish.
2. The tubes shall be 316Ti Stainless Steel and shall be fitted with Aluminum Alloy internal heat transfer fins creating no less than 10 square feet of fireside heating surface per boiler horsepower.
3. The Vessel shall be mounted on a structural steel stand with exhaust gasses collected in a non-corroding drain collection box with drain fitting for draining condensation from the products of combustion. A condensate neutralizing box with limestone chips shall be shipped loose for field installation by the contractor.
4. The top tubesheet shall be fully accessible without burner disassembly or removal from the boiler. The burner assembly shall be complete with lifting hinges and pneumatic lifters.
5. Each boiler shall be constructed in accordance with the A.S.M.E. Section IV Code and bear the "H" stamp and shall be manufactured within an ISO 9001 Certified facility to ensure high quality standards.
6. To drain the boiler, a bottom-threaded connection shall be provided at the front of the boiler and field piped by the installing contractor with a manual full size shutoff valve to drain.

B. Burner Design

1. General: Burner shall be forced draft type. It shall be mounted in and integral with the boiler hinged top door so when the door is opened the burner head, furnace, tubesheet, and tubes are exposed.
2. The burner shall be of the Unitized Venturi, Gas Valve, Blower, and burner head design. This pre-mix design shall utilize a variable speed fan connected to a venturi to simultaneously modulate fuel and air for a minimum a 5:1 turndown ratio. The venturi design shall also act as a method for compensating for changes in barometric pressure, temperature and humidity so the excess air levels are not adversely affected by changes in atmospheric conditions.
3. Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame. Combustion shall take place on the surface of the burner mantle, which shall be constructed of a woven fecralloy material creating a 360 degree low temperature radiant flame.
4. Emissions: The equipment shall be guaranteed to limit NOx emissions to 20 PPM or less, as certified by an independent testing lab. NOx emission levels shall not be exceeded at full operating conditions and at designed turndown of the burner. Proof of such emissions certification shall be made available to the engineer and demonstrated at the time of start-up. External flue gas recirculation shall not be accepted for emission control.
5. Gas Train - As a minimum, the gas train shall meet the requirements of CSA and ASME CSD-1 and shall include:
 - a. Low Gas Pressure Interlock, manual reset.
 - b. High Gas Pressure Interlock, manual reset.
 - c. Upstream and downstream manual test cocks.
 - d. Ball Type manual shutoff valve upstream of the main gas valve.
 - e. Unibody double safety gas valve assembly.
 - f. Gas Pressure Regulator
 - g. Union connection to permit burner servicing.

6. Combustion Air Proving Switch shall be furnished to ensure sufficient combustion airflow is present for burner ignition firing.
7. To ensure that proper draft is not blocked in the stack, the burner shall include a High Air Pressure Switch sensing the outlet pressure connection relative to stack back draft.

C. Boiler Trim

1. Safety valve(s) shall be ASME Section IV approved side outlet type mounted on the boiler air vent outlet. Size shall be in accordance with code requirements and set to open at 60 psig.
2. Temperature and pressure gauge shall be mounted on the water outlet.
3. Solid State Low water cut-off probe with manual reset and test switch.
4. Manual Reset High Limit Temperature control; range not to exceed 210 F.
5. Outlet water supply sensing probe for operating water limit setpoint.
6. Return water-sensing probe for operating water limit setpoint.
7. Boiler manufacturer shall provide a circulating pump for each boiler specifically sized for the system.

D. Boiler Controls

1. The Boiler shall include a Computerized Boiler Burner control which shall be an integrated, solid state digital micro-processing modulating device, complete with sequence indication, fault reset, mode selection, and parameter set-point switches. It shall be mounted at the front of the boiler panel for easy access and viewing.
2. Controller shall provide for both flame safeguard and boiler control and shall perform the following functions:
 - a. Burner sequencing with safe start check, pre-purge, electronic direct spark ignition, and post purge. Flame rod to prove combustion.
 - b. Flame Supervision. The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent six faults. The control shall be connected to a keyboard display module that will retrieve this information.
 - c. Safety Shutdown with display of error.
 - d. Modulating control of the variable speed fan for fuel/air input relative to load requirements.
 - e. Gas pressure supervision, high and low.
 - f. Combustion Air Proving Supervision.
 - g. High Air Pressure [back draft too high] Supervision.
 - h. The supply temperature and set-point temperature shall be displayed at all times by an LED readout. Output shall be continuous PID via 4 -20 mA current.
 - i. Controller shall have an option for communication device to a laptop computer interface for service, troubleshooting, and start-up.
 - j. Include the programming of system circulating pump and provide the programming of 2 heating loops.
 - k. All parameter input control set-points shall be factory downloaded with jobsite conditions programmed at the time of initial jobsite operation.
 - l. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to CSA requirements.
 - m. Electrical power supply shall be 120 volts, 60 cycle, single phase for the fan and for control circuit requirements.
 - n. A sequencing control shall be provided to stage the boilers. The control shall include automatic rotation of lead boiler, an adjustable outdoor reset schedule, multiple setback

schedules and a digital display. The control shall force each boiler to low fire, before allowing any boiler to operate at high fire. When all boilers are running, they will then be modulated in unison. The control shall be supplied by the boiler supplier.

- o. Boilers shall be provided with a BACnet interface card for communication and control through the new BAS. Manufacturer shall coordinate available points with the Contractor for control sequence and alarms.

2.3 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.4 VENTING KITS

- A. Provide complete system ASTM A959, Type 29-4C stainless steel pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, dilution tank and sealant. Acceptable manufacturers include: Z-Flex-Z-Vent III, Heat Fab, Inc. - Saf-T-Vent, Dura-Vent - Fas N Seal and Metal-Fab, Inc. - Corr/Guard. Install vent piping per manufacturer's written instruction.
- B. Combustion-Air Intake: Complete system PVC, Vent terminal with screen, inlet air coupling and sealant. Install per manufacturer's written instructions.

2.5 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Allow Using Agency access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- I. Boiler Venting:
 - 1. Install double wall flue venting kit and combustion-air intake.
- J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. 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 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Using Agency's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 52 16

SECTION 23 75 00 – HEAT TRANSFER

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Contractor: Provide and install heat transfer systems as shown on the drawings and as specified. Work includes, but is not limited to, the following:
 - a. Unit heaters
 - b. Reheat coils
 - c. Finned tube

B. Work Not Included

1. Materials, equipment or final connections to items of equipment specified or noted on the drawings to be furnished or executed under another contract.

1.2 RELATED WORK

A. Specified elsewhere:

1. Sections: Architectural / Structural and General Work
2. Section 22 00 20 - Mechanical Insulation
3. Division 23 - Mechanical Systems

1.3 QUALITY ASSURANCE

- A. Use only new material and apparatus of the specified design and manufacturer. Furnish all materials in accordance with latest ANSI, AWWA, ASTM, NFPA, ARI, ASME, IBR standards and other applicable standards or codes.

1.4 SUBMITTALS

- A. See Architectural Sections for requirements.

PART 2 - PRODUCTS

2.1 AHU COILS

- A. Furnish and install heating and cooling coils as shown on drawings and as specified. Coil capacities and pressure drops shall be certified in accordance with ARI Standard 410.
- B. All coils installed in air handling units shall be compatible with air handling units and shall be provided as part of air handling unit package.
- C. Forward shop drawing submittals to the Architect / Engineer for review.
- D. Water Coils

1. Coils shall be completely drainable with full height header on each row of tubes. Each header shall be red brass and have bottom drain and top vent plugs. Water supply connection shall be at bottom of leaving air side header and return connection shall be at top of entering air side header.
2. Coils shall be fabricated with 5/8" OD seamless copper tubing, die formed seamless U-Bends, silver soldered in place, and mechanically bonded aluminum fins (see schedules for spacing). 1/2" OD tubing may be used only if specifically scheduled on drawings.
3. Turbulators shall not be provided unless specifically scheduled on the drawings.
4. The number of rows indicated on the schedules shall not be decreased for any reason. If additional rows are required to provide specified performance then the additional rows shall be added and the fans adjusted accordingly, all at no additional cost to the Owner.
5. Heating and Cooling coils shall be provided with .035" minimum tube wall thickness and .010" minimum fin thickness.
6. Fins shall be flat or nearly so. Spiral fins are not acceptable.
7. Fin density shall be 120 fins per foot maximum.
8. All cooling coils shall have drip pans and drain connections. Pipe drain pans to floor drain full size. Provide trap with trap leg designed to withstand the maximum positive and / or negative pressure encountered. See Specification Section 23 85 00 for drain pans in air handling units.
9. Frames and intermediate supports, where required, shall be 16 gauge galvanized steel with drilled flanges. Frames shall be arranged to allow for free expansion of tubes. On multiple coil installations, each coil shall be individually removable without disturbing other coils and shall have individual drain pan under each of the upper coils with drain extended down to main drain pan.
10. All coils shall be tested with 250 psig air pressure while immersed in water tank.
11. Multiple coils shall be piped to give equal pressure drops through each coil circuit. Provide a separate balancing valve in the return from each coil. A single control valve may be used for multiple coils unless specified otherwise.
 - a. If single coils are indicated on the documents and the Contractor provides more than one coil then the additional piping costs to the Contractor shall be borne by the Contractor and passed on to the vendor providing the coils.
12. Protection of coils from dirt shall be the Contractor's responsibility. Temporary filters shall be installed at Contractors expense to protect all coils from construction dirt.
13. Protection of coils from freeze-up shall be the Contractor's responsibility. Coils shall be drained and charged with glycol prior to the onset of freezing temperatures. All frozen coils shall be the Contractor's responsibility.

2.2 CABINET-TYPE UNIT HEATERS

- A. Provide and install cabinet unit heaters. Coils shall be for water as required and shall have capacity as called for in the schedule.
- B. Cabinets shall be constructed of 16 gauge furniture steel, except backs, which may be 18 gauge. Fronts shall be removable for easy access to motor, blower, heating element and controls. All parts shall be bonderized and finished with factory applied baked enamel finish, color as selected by the Architect / Engineer at the shop drawing review stage.
- C. Multi-speed fan switches shall be factory mounted inside unit.
- D. Fans shall be centrifugal type, direct connected to 3-speed motors.

- E. All piping, devices and controls shall be concealed inside the cabinet.
- F. All units shall be furnished with a steel filter frame to receive disposable filter media by American Air Filter, Farr or Continental. Provide a quantity of filter media sufficient to replace media furnished with the units and change all media at the time of occupancy of the structure.
- G. Acceptable Manufacturers
 - 1. Trane
 - 2. Sterling
 - 3. International Environmental
 - 4. Carrier
 - 5. Rittling
 - 6. Sigma
 - 7. Daikin Applied
 - 8. Vulkan
- H. Forward shop drawing submittals to the Architect / Engineer for review.

2.3 PROPELLER-TYPE UNIT HEATERS

- A. Provide and install propeller unit heaters.
- B. Heaters shall have a maximum decibel rating 40.0 on high speed and shall be driven by 120 volt, single phase, 60 cycle motors. Fan blade shall be directly mounted through resilient-type mountings. Heating elements shall consist of nonferrous material and shall be built of 1/2" OD copper tubes, silver soldered to bronze headers, with fins mechanically attached to the tubes by an expanding process. No gaskets or bolts of any kind shall be used. Heaters shall be furnished complete with waste-packed sleeve bearings or grease-packed ball bearings. The unit heater ratings shall be in strict accordance with the ASHRAE Codes for unit heaters. Heater cabinets shall have factory applied baked enamel finish applied over bonderized metal.
- C. Acceptable Manufacturers
 - 1. Trane
 - 2. Sterling
 - 3. Modine
 - 4. Carrier
 - 5. Markel
 - 6. Raywall
- D. Forward shop drawing submittals to the Architect / Engineer for review.

2.4 HOT-WATER FINNED-TUBE HEATERS

- A. Performance Ratings: Rate baseboard radiation heaters according to Hydronics Institute's "I=B=R Testing and Standard for Baseboard Radiation."
- B. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on polypropylene element glides. One end of tube shall be belled.
- C. Enclosures: Minimum 18 gauge thick steel.

1. Pedestal style.
2. Removable extruded aluminum grille.
3. End panel.
4. End caps.
5. Inside and outside corners.
6. Valve access door.
7. Joiner pieces.
8. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
9. Element Brackets: Primed and painted steel to support front panel and element.

D. Acceptable manufacturers:

1. Rittling.
2. Sterling.
3. Slant/Fin.
4. Sigma

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment per manufacturer's written instructions.

END OF SECTION 23 75 00

SECTION 23 85 00 – AIR HANDLING

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Contractor: Provide and install air handling systems as shown on the drawings and as specified. Work includes, but is not limited to, the following:
 - a. Outdoor air handling units
 - b. Fans and accessories

B. Work Not Included:

1. Materials, equipment or final connections to items of equipment specified or noted on the drawings to be furnished or executed under another contract.

1.2 RELATED WORK

A. Specified elsewhere:

1. Sections: Architectural / Structural and General Work
2. Division 23 - Mechanical Systems

1.3 QUALITY ASSURANCE

- A. Use only new material and apparatus of the specified design and manufacturer. Furnish all materials in accordance with latest ANSI, ASTM, NFPA, AMCA, SMACNA, ASHRAE, UL, MICA, AABC, ARI, ADC standards and other applicable standards or codes.

1.4 SUBMITTALS

- A. See Architectural Sections for requirements.

PART 2 - PRODUCTS

2.1 OUTDOOR AIR HANDLING UNITS (Rooftop Units)

A. Unit Casing

1. Unit manufacturer shall ship unit in segments as specified by the contractor for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
2. Casing performance - Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft² of casing surface area) = CL X P^{0.65}.

3. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.
4. Under 55F supply air temperature and design conditions on the exterior of the unit of 81F dry bulb and 73F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.
5. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).
6. Floor panels shall have tread plate flooring - aluminum tread plate minimum 0.125".
7. Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.
8. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft²*°F/BTU.
9. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
10. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.
11. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.
12. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.
13. The fan section and discharge plenum section shall have 2" of additional insulation and perforated liner for sound attenuation.

B. Access Doors

1. Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.
2. All doors downstream of the cooling coil shall be provided with a thermal break construction of door panel and door frame.
3. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
4. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.
5. Handle hardware shall be designed to prevent unintended closure.
6. Access doors shall be hinged and removable without the use of specialized tools to allow.
7. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.
8. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

9. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.
10. Multiple door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.

C. Primary Drain Pans

1. All cooling coil sections shall be provided with an insulated, double-wall, stainless steel drain pan.
2. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements. See section 2.07, paragraph F through H for specifications on intermediate drain pans between cooling coils.
3. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.
4. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.
5. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.
6. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.
7. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.
8. If drain pans are required for heating coils, access sections, or mixing sections they will be indicated in the plans.

D. Fans

1. Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Construct door(s) per Section 2.04.
2. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25% and 100% of design RPM. If fans are not factory-tested for vibration and alignment, the contractor shall be responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.
3. All fans, including direct drive plenum fans, shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with spring isolators. Unit sizes up to a nominal 4,000 CFM shall have 1-inch spring isolation. Units with nominal CFM's higher than 4,000 shall have 2-inch springs. A flexible connection (e.g. canvas duct) shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping,

and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

E. Motors and Drives

1. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have motors field installed by the contractor. The contractor shall be responsible for all costs associated with installation of motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.
2. Motors shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
3. Fan Motors shall be heavy duty, open drip-proof operable at 460 volts, 60Hz, 3-phase. If applicable, motor efficiency shall meet or exceed NEMA Premium efficiencies.
4. Direct driven fans shall use 2-pole (3600 rpm), 4-pole (1800 rpm) or 6-pole (1200 rpm) motors, NEMA Design B, with Class B insulation capable to operate continuously at 104 deg F (40 deg C) without tripping overloads.
5. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.
6. Manufacturer shall provide for each fan a nameplate with the following information to assist contractor in start up and service personnel in maintenance. Fan and motor sheave part number. Fan and motor bushing part number. Number of belts and belt part numbers. Fan design RPM and motor HP. Belt tension and deflection. Center distance between shafts

F. Coils

1. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.
2. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
3. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
4. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
5. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.
6. ½" tube coils shall have minimum tube thickness of 0.025" and 5/8" tubes shall have minimum tube thickness of 0.024".
7. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of

sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the sections primary drain pan.

8. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.
9. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

G. Filters

1. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Construct doors in accordance with Section 2.04. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size, and quantity needed to maximize filter face area of each particular unit size.
2. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule
3. Manufacturer shall provide one set of startup filters. Provide two additional sets of filters. One set shall be installed at the completion of the project and the third set shall be turned over to the Owner as a replacement set. Provide an exterior pressure gauge at the unit to check pressure drop across filters.

H. Dampers

1. All dampers, with the exception of external bypass and multizones (if scheduled), shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

I. Hood Inlet

1. Inlet hoods for each outside damper shall be provided with a high performance sine-wave moisture eliminator to prevent entrainment of water into the unit from outside air. Wire mesh screens shall not be acceptable as a moisture eliminator. Exhaust hoods shall be provided on exhaust air openings.

J. Discharge Plenum Sections

1. Plenums shall be provided as indicated in the schedule and plans to efficiently turn air and provide acoustical attenuation. Discharge plenum opening types and sizes shall be scaled to meet pressure drop requirements scheduled and align with duct takeoffs. Provide additional 2" insulation and perforated liner for sound attenuation.
2. Provide grating over bottom opening for the unit.

K. Marine Lights

1. Marine lights shall be provided throughout AHUs as indicated on the schedule and plans. Lights shall be instant-on, light-emitting diode (LED) type to minimize amperage draw and shall produce lumens equivalent to a minimum 75W incandescent bulb (1200 lumens). LED lighting shall provide instant-on, white light and have a minimum 50,000 hr life.
2. Light fixture shall be weather-resistant, enclosed and gasketed to prevent water and dust intrusion.
3. Fixtures shall be designed for flexible positioning during maintenance and service activities for best possible location providing full light on work surface of interest and not being blocked by technician.
4. All lights on a unit shall be wired in the factory to a single on-off switch.
5. Installing contractor shall be responsible for providing 115V supply to the factory-mounted marine light circuit (unless single-point power is specified to be provided by AHU manufacturer).

L. Convenience Outlets

1. A 15-amp, 115V GFCI convenience outlet shall be provided by the AHU manufacturer. The outlet shall be separate from the load side of the equipment per NEC requirements. Installing contractor shall be responsible for providing 115V supply to the factory-mounted GFCI outlet circuit per NEC (even when single-point power is specified to be provided by AHU manufacturer).

M. Variable Frequency Drives (VFDs)

1. Variable frequency drives shall be provided, mounted and wired by the Contractor as indicated on the schedule and drawings. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. The VFDs shall be UL listed. The listing shall allow mounting in plenum or other air handling compartments. Acceptable VFD manufacturers include: ABB, Square D and Dan Foss.
2. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.
3. With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
4. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
5. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL 508 certified for the building and assembly of option panels. Assembly of separate panels with options by a third-party is not acceptable. The appropriate UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel.
6. The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor.

7. The VFDs full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
8. The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.
9. An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.
10. Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.
11. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.
12. Galvanic and/or optical isolation shall be provided between the VFDs power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.
13. The VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
14. Protective Features
 - a. Protection shall be provided against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, undervoltage, VFD overtemperature and motor overtemperature. The VFD shall display all faults as words. Codes are not acceptable.
 - b. The VFD shall be protected from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD shall continue to operate with reduced output with an input voltage as low as 164 V AC for 208/230 volt units, 313 V AC for 460 volt units, and 394 volts for 600 volts units.
 - c. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
 - d. The VFD package shall include semi-conductor rated input fuses to protect power components.
 - e. To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise the AHU manufacturer shall ensure that inverter rated motors are supplied.
 - f. The VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
 - g. The VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.
 - h. The VFD shall catch a rotating motor operating forward or reverse up to full speed.
 - i. The VFD shall be rated for 100,000 amp interrupting capacity (AIC).

- j. The VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD shall identify which of the output phases is low or lost.
- k. The VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt units, 539 V AC on 460 volt units, and 690 volts on 600 volt units.

15. Interface Features

- a. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference. On units with bypass, a VFD/Off/Bypass selector switch shall be provided.
- b. The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.
- c. The VFD shall provide digital manual speed control. Potentiometers are not acceptable.
- d. A lockable, alphanumeric backlit display keypad shall be provided. The keypad shall be remotely mountable up to 10 feet away using standard 9-pin cable.
- e. The keypads for all sizes of VFDs shall be identical and interchangeable.
- f. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFDs keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.
- g. The display shall be programmable to display in English, Spanish and French at a minimum.
- h. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
- i. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.
- j. The VFD shall include a standard EIA-485 communications port and capabilities to be connected at a future date to a Johnson Controls N2 Metasys or Siemens FLN system at no additional cost to the owner. The connection shall be software selectable by the user.
- k. At a minimum, the following points shall be controlled and/or accessible:

- (1) VFD Start/Stop
- (2) Speed reference
- (3) Fault diagnostics
- (4) Meter points
 - (a) Motor power in HP
 - (b) Motor power in kW
 - (c) Motor kW-hr
 - (d) Motor current
 - (e) Motor voltage
 - (f) Hours run
 - (g) 2 feedback signals
 - (h) DC link voltage
 - (i) Thermal load on motor
 - (j) Thermal load on VFD
 - (k) Heatsink temperature

- l. Four additional Form C 230 volt programmable relays shall be available for field installation within the VFD
- m. Two set-point control interfaces (PID control) shall be standard in the unit. The VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
- n. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- o. Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.
- p. Sleep mode shall be provided to automatically stop the VFD when its speed drops below set sleep level for a specified time. The VFD shall automatically restart when the speed command exceeds the set wake level.
- q. The sleep mode shall be functional in both follower mode and PID mode.
- r. A run permissive circuit shall be provided to accept a ζ system ready ζ signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
- s. The following displays shall be accessible from the control panel in actual units: Reference Signal Value, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and unit CFM.
- t. The display shall be programmed to read in inches of water column (in-wg).
- u. The VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
- v. If the temperature of the VFDs heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFDs heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
- w. The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
- x. The VFD shall store in memory the last 10 faults and related operational data.
- y. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- z. Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.
- aa. Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.
- bb. Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24V DC status indication.
- cc. Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.

16. Adjustments

- a. The VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.
- b. A minimum of sixteen preset speeds shall be provided.
- c. Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.
- d. Four current limit settings shall be provided.
- e. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit and inverter overload.
- f. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
- g. An automatic ζ on delay ζ shall be selectable from 0 to 120 seconds.

17. Service Conditions

- a. VFDs shall provide full output in an ambient temperature from -10 to 50°C (14 to 104°F).
- b. VFDs shall provide full output in a relative humidity from 0 to 95%, non-condensing.
- c. VFDs shall provide full output up to 3,300 feet elevation without derating.
- d. VFDs shall provide full output with an AC line voltage variation from -10 to +10% of nominal voltage.
- e. No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

18. Warranty

- a. The VFD shall be warranted by the manufacturer for a period of 42 months from date of shipment, or 36 months from start-up, which ever occurs first. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory-authorized on-site service.

N. Factory Wiring of Lights, VFDs, and Combination Starters/Disconnects

1. VFDs shall be wired per NEC, UL, and NFPA 90A requirements. Units with factory-mounted controls shall also include power wiring from the VFD or starter/disconnect control transformer to the control system transformers. Units with VFDs and factory-mounted controls shall have a binary start-stop signal and an analog speed signal wired from the direct digital controller to the VFD.
2. All power wiring for voltages greater than 24V and traveling through multiple unit sections shall be contained in an enclosed, metal, power-wiring raceway or EMT. Sections less than 6-inch in length may be contained in FMC.
3. The Contractor and RTU Manufacturer Service Technician shall unit for proper operation and fan rotation.
4. For fan motors not supplied with a factory mounted and wired starter or VFD, the unit manufacturer shall supply a 4 X 4 NEMA 4 junction box on the exterior of the fan section(s) with wiring, prewired to the fan motor, to allow for ease of field installation of a starter or VFD.
5. On units provided with factory mounted and wired supply fan starter or VFD and DDC controls, the manufacturer shall provide a single point of power. Line-to-24v transformers

shall be provided with sufficient vA to power the unit mounted controller and factory installed control points.

O. Acceptable Manufacturers

1. Trane
2. York Solution YC
3. Carrier 39CC
4. Daikin Applied Skyline Series

P. Warranty

1. Provide comprehensive 3-year warranty including parts and labor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all equipment per manufacturer's printed recommendations.

3.2 EXAMINATION

- A. Verify that roof is ready to receive work.
- B. Verify that proper power supply is available.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork. Install roof mounting curb level.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Package rooftop unitary manufacturers shall maintain service capabilities no more than 100 miles from the jobsite.
- B. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

END OF SECTION 23 85 00

SECTION 23 88 00 – AIR DISTRIBUTION

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Contractor: Provide and install air distribution systems as shown on the drawings and as specified herein. Work includes, but is not limited to, the following:
 - a. Filters
 - b. Volume dampers
 - c. Roof curbs and rails
 - d. VAV boxes
 - e. Leak test high pressure ductwork

B. Work Not Included:

1. Materials, equipment or final connections to items of equipment specified or noted on the drawings to be furnished or executed under another contract.

1.2 RELATED WORK

A. Specified elsewhere:

1. Sections: Architectural / Structural and General Work
2. Division 23 - Mechanical Systems

1.3 QUALITY ASSURANCE

- A. Use only new material and apparatus of the specified design and manufacturer. Furnish all materials in accordance with latest AMCA, SMACNA, ANSI, ASTM, NFPA, ASME, IBR, UL standards and other applicable standards or codes.

1.4 SUBMITTALS

- A. See Architectural Sections for requirements.

PART 2 - PRODUCTS

2.1 MEDIUM EFFICIENCY DISPOSABLE FILTERS

- A. Filters shall be 2" thick as shown or specified on the drawings. Filters shall be rated by ASHRAE Test Standard 52-76 at 25-30% efficiency and 90-92% arrestance. Each filter shall consist of a pleated, non-woven cotton fabric media, a media support grid with an effective open area of not less than 96% and an enclosing frame of a rigid, heavy-duty, high wet-strength beverage board with diagonal support members. The wire grid shall be bonded to the filter media and the frame diagonal support members shall be bonded to the air-entering and air-exit side of each pleat. The inside periphery of the enclosing frame shall be bonded to the filter pack, eliminating the possibility of air bypass.

- B. The 2" filter shall have not less than 4.6 square feet of media per 1 square foot of filter face area and shall contain not less than 15 pleats per lineal foot. Initial resistance at 500 FPM approach velocity shall not exceed .28 WG.
- C. Medium efficiency filters shall be used in filter sections provided by air handling unit manufacturers. Filters to be Farr 30/30, Eco-Air Series E-35 or Continental Conopleat.

2.2 LOW PRESSURE DUCTWORK LEAKAGE

- A. Low pressure duct leakage shall not exceed 5% as determined by comparing central station air delivery with the sum of all terminal outlet air deliveries. If duct leakage exceeds specified amount or there is noticeable noise, then Contractor shall take all corrective measures, at his expense, necessary to reduce leakage to specified levels.

2.3 DUCT SEAL CLASSIFICATION

- A. All ducts shall be sealed in accord with the following SMACNA seal classification.

<u>Seal Class</u>	<u>Duct Pressure</u>	<u>Requirements</u>
A	4" WC and Up	All traverse joints, longitudinal, seams and duct wall penetrations, also see SMACNA high pressure duct construction standards.
B	Up to 3"	All transverse joints and longitudinal seams.
- B. The terms "seal" or "sealed" shall mean the use of tape or mastic plus gasketing as appropriate. Tapes shall not be applied to bare metal nor to dry sealant. See "Duct Sealant" section of these specifications. Oil base caulking and glazing compounds shall not be used.

2.4 SEALANT AND GASKETS

- A. Water-Based Joint and Seam Sealant:
 1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
 10. VOC: Maximum 395 g/L.
 11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 12. Service: Indoor or outdoor.
 13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

2.5 ROOF CURBS

- A. Where curbs cannot be provided by the manufacturer of the equipment being supported, the Contractor shall furnish and install Pate Empco Inc., Thycurb or RPS Inc. prefabricated steel roof curbs.

- B. Curbs shall be suitable for mounting on pertinent roof deck. Curbs shall be 12" high overall and built-in cant starting 1.50" above base plate, lined with 1.50" thick 3 lb. rigid insulation, 18 gauge galvanized steel with continuous welded corner seam and factory installed wood nailer. Curbs shall be installed level.
- C. Curb shall be capable of supporting 500 lbs. per lineal foot when uniformly distributed.
- D. Coordinate installation of curb with the Contractor.
- E. Forward shop drawing submittals to Architect / Engineer for review.
- F. For specific curb requirement for Area A and Area F See Specification Section 23 0548.

2.6 VARIABLE AIR VOLUME BOXES

- A. Provide and install variable air volume cooling with reheat terminal units as shown on the drawings and as specified herein. See Division 25 for other air terminal devices.
- B. Casing shall be welded galvanized steel with round 4" deep inlet collars of the proper diameter. Casing leakage shall not exceed 2% at .5" WC for 200 through 2,000 cfm units and shall not exceed 3% at .5" WC for larger units. Contractor shall verify that units will fit in available space before submitting shop drawings. Units shall be suitable for use at up to 10" WC Casing shall have hanger provisions.
- C. Certain casings may be provided with multiple round outlet collars in configuration shown on drawings. Each outlet shall be provided with a factory-installed balancing damper and lockable damper operator to allow air balance to remote diffusers. Outlet sizes shall match flex sizes shown on drawings.
- D. Casing shall be internally insulated with not less than .5" thick, 1.5 pcf density glass fiber acoustic and thermal insulation. Insulation shall have high-density facing and shall comply with NFPA 90A and be UL listed.
- E. Units shall incorporate a means of accurately measuring system pressure at all flow rates. Averaging sensors or pivoting flow diverter rings shall be used which automatically compensate for distorted flow conditions entering the units.
- F. Units shall be system pressure independent featuring pneumatic volume regulation with continuous compensation for system pressure fluctuations from minimum to maximum volumes. As per thermostat demand, the volume regulator shall continuously monitor and maintain the required air quantity until the thermostat resets the control point. Volume regulator shall be factory mounted and piped to actuator. Factory calibrated field-adjustable setpoints shall be provided to set minimum and maximum cfm. Field adjustments shall be external to the unit. Control action shall be normally open.
- G. Volume regulation shall be via one of the following methods:
 - 1. Opposed blade dampers with neoprene covered edges.
 - 2. Cylindrical die cast aluminum airflow control device featuring tapered valve.

- H. Volume regulating means shall have been life-tested in excess of one million cycles, without failure, to verify long-term reliability. Leakage through tight-shut volume regulation means shall not exceed 6% of rated airflow at 3" WC
- I. Terminal unit manufacturer shall mount, wire, and / or pipe all terminal unit controls, including damper actuator and terminal unit controller furnished by the contractor and per the manufacturers instructions. The terminal unit manufacturer furnish all transformers, relays, air flow rings, and enclosures to meet the requirements specified in Section 25 95 60. Damper actuators shall be mounted to damper shafts and factory tested to assure proper actuator and damper position in the full open and closed positions.
- J. All units shall be configured for "master" operation unless specified otherwise. Units specified as configured for "slave" operation (i.e., under the control of a "master" box) shall be field convertible to master operation.
- K. Unit manufacturers shall furnish certified sound data for both casing radiated and discharge sound levels as tested in an ADC certified laboratory in accordance with ADC Standard 1062R4 and shall include 2nd through 7th octave band data for all unit sizes. Both discharge and radiated N.C. levels shall be based on a 10 dB room absorption factor for both radiated and discharge sound data. Sound levels shall not exceed N.C. 35 at 2.50" WC inlet pressure based on the above criteria at unit-rated airflow.
- L. Unit size selections on drawings are based on:
 - 1. A minimum inlet static pressure of 0.75" WC for worst case box.
 - 2. A maximum pressure drop through VAV box and coil of .50 inch WC.
 - 3. A maximum pressure drop through that unit outlet of .10 inch WC.
 - 4. Remaining available static pressure at that unit outlet of .15 WC with outlet dampers full-open.
- M. Provide field-mounted orifice plates on duct runouts where required (or scheduled) to dissipate excess static pressure. Duct runout size shall match unit inlet size.
- N. Forward shop drawing submittals to Architect / Engineer for review. Include noise data, pressure drops, actuator information and volume regulator information.
- O. Units shall be independently supported from the structure and shall be fully accessible after installation. Provide a straight inlet duct at least five duct diameters or equivalent diameters in length to allow uniform entering airflow conditions. Units shall be installed upright (units will not function properly if installed upside down).
- P. Upon completion of all work each unit shall be tested for proper operation and setpoints readjusted if necessary.
- Q. VAV system is designed in accordance with static regain principle. If Contractor proposes a substitution for the specified box manufacturer, the Contractor shall provide sufficient data to allow evaluation of the substitution effect on NC level, duct sizing, static pressure, etc. All changes in the system necessitated by the substitution shall be the full and complete responsibility of the Contractor.
- R. Acceptable Manufacturers

1. Price
 2. Titus
 3. Carnes
 4. Siemens
 5. Trane
 6. Carrier
 7. Enviro-Tec
 8. Nailor.
- S. Forward shop drawing submittals to Architect / Engineer for review. Include all scheduled data in submittal. Submittals without scheduled data will not be reviewed.
- T. Reheat coils shall be installed with duct access doors on the inlet side of the box to allow cleaning. Gasketed access doors shall be:
1. 8" x 8" for coils up to 12" x 12".
 2. 12" x 12" for coils larger than 12" x 12".

PART 3 - EXECUTION

3.1 DEMOLITION

- A. Contractor shall remove all existing materials, system components, accessories and related items that will not be re-used.
- B. Contractor shall ensure that system is inactive before disabling the system. Contractor shall ensure that removal of system will not compromise the Owner's operations before removal occurs.
- C. Partial removals shall extend back to nearest active main. Provide and install caps or pipe plugs at main.
- D. No ducts shall be left open as a result of demolition operations. Cap or plug all open ducts.
- E. All hangers and clamps shall be removed as part of demolition work if they are not re-used.
- F. All removed equipment and materials become the property of the pertinent removing Contractor unless otherwise noted.

3.2 DUCT CLEANLINESS

- A. All ductwork shall be fabricated, stored, handled and installed in strict accordance with the SMACNA Duct Cleanliness for New Construction Guidelines, Advanced Level.
- B. Temporary Storage.
 1. Job site duct material storage areas shall be located away from high dust generating processes such as masonry or tile cutters, cutoff saws, drywall sanding, mortar and plaster mixers, roof pitch kettles, portable electric generators, and main walkways that will be constantly broom swept.
 2. To prevent ductwork material damage from standing water, storage locations shall include pallets or blocking to keep fabricated metal ductwork above the floor surface. If there is risk

- of water runoff from above or dusty work areas cannot be avoided, coverage shall be used to protect stored materials.
3. Suitable areas for temporary storage shall be designated on the jobsite. The Contractor shall assume that no clean storage space will be available at the job site and that all ductwork stored at the side shall be covered until it is installed.
- C. Scheduling of Work. During startup operation of the HVAC system, special care shall be taken to protect the return air system by installing temporary filters at the air handling unit.
- D. Condition of Ducts. Ductwork leaving the premises of the manufacturer may include some or all of the following:
1. All self-adhesive labels or marking for part(s) identification are to be applied to the external surfaces only.
 2. Exposed mastic sealant.
 3. Light zinc oxide coating on the metal surface.
 4. A light coating of oil on machine formed ductwork.
 5. Minor protrusions into the airway of rivets, screws, bolts and other jointing devices.
 6. Internal insulation and associated fasteners.
 7. Discoloration marks from plasma cutting process.
- E. Production and Site Delivery Requirements
1. To maintain cleanliness during transportation, all ductwork shall be sealed either by blanking or capping duct ends, bagging small fittings, surface wrapping or shrink wrapping.
- F. Installation. Before the installation of individual duct sections they are to be inspected to ensure that they are free from all debris, but need not be wiped or specially cleaned.
- G. Protection of Ductwork Risers. All risers must be covered to prevent the entry of debris into the duct.
- H. Site Storage
1. A clean and dry environment where the ductwork is protected from dust, must be provided for the storage of ductwork prior to installation.
 2. All sealed ends shall be visually examined and if damaged resealed with an appropriate material.
- I. Installation.
1. The work area shall be clean, dry and the work protected from dust. Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.
 2. The internal surfaces of the uninsulated ductwork shall be wiped to remove excess dust immediately prior to installation.
 3. All open ends on completed ductwork and overnight work-in-progress shall be sealed.
- J. Air distribution equipment shall be stored, handled and delivered in a manner similar to the ductwork. Equipment should be up off the floor to prevent water from entering, access doors should be kept shut as much as possible to stop dirt from entering equipment and all openings must be sealed until duct connections are made.

- K. All new air handling equipment that had to be opened and worked in during installation shall be cleaned and disinfected by the Contractor prior to being put into service. Cleaning of the air handling equipment shall be done with materials and methods approved by the National Air Duct Cleaners Association (NADCA).
- L. If the permanent air distribution system is used for temporary heating or cooling, the Contractor must provide adequate filtering to protect the cleanliness of the duct systems, including changing of the filters on an as-needed basis. In addition, the air distribution system must be modified so that all air circulated is 100% outdoor air with no air from the space returning through the return air system.
- M. If, during inspection, the interior of the air distribution system is found not to be clean, the Contractor shall clean and disinfect the dirty sections of the system at his expense. Cleaning shall be done using a vacuum system with agitation as per cleaning methods approved by the National Air Duct Cleaners Association (NADCA).
- N. Access Provisions to In-duct Plant
 - 1. Access covers shall be firmly fitted in position on completion of each section of the work.

3.3 DUCT SEALING

- A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 LEAK TESTING HIGH PRESSURE DUCTWORK

- A. Contractor shall test all new high pressure duct. One of the following two test methods shall be used:
 - 1. Bubble method:
 - a. Disconnect all equipment that could be damaged by testing.
 - b. Cap all openings.
 - c. Slowly build up pressure to 8" WC.

- d. Bubble-test all seams and joints with soap suds.
 - e. Repair all leaks and retest until leak-free.
 - f. Reconnect equipment.
2. SMACNA method:
- a. For complete description follow the methodology detailed in SMACNA "Air Duct Leakage Test Manual" first edition 1985.
 - b. The typical test apparatus consists of:
 - (1) A source of high pressure air - a portable rotary blower.
 - (2) A flow measuring device, usually an orifice assembly consisting of straightening vanes and an orifice plate mounted in a straight tube with properly located pressure taps. Each orifice assembly is accurately calibrated with its own calibration curve. Pressure and flow readings are usually taken with U-tube manometers.
 - c. Test for audible leaks as follows:
 - (1) Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
 - (2) Start the blower with its control damper closed (some small blowers popularly used for testing ducts may damage the duct because they can develop pressures up to 25 inches W.G.).
 - (3) Gradually open the inlet damper until the duct pressure reaches 2 inches W.G. in excess of designed duct operating pressure. The test pressure is read on manometer No. 1. Note that the pressure is indicated by the difference in level between the two legs of the manometer and not by the distance from zero to the reading on one leg only.
 - (4) Survey all joints for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealants have set.
 - d. After all audible leaks have been sealed, the remaining leakage should be measured with the orifice section of the test apparatus as follows:
 - (1) Start blower and open damper until pressure in duct reaches 25% in excess of designed duct operating pressure.
 - (2) Read the pressure differential across the orifice on manometer No. 2. The leakage rate in cfm is read directly from the calibration curve. If there is no leakage, the pressure differential will be zero.
 - (3) Total allowable leakage should not exceed one (1) percent of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
 - (4) If all audible leaks have been corrected, it is unlikely that the measured leakage will exceed one (1) percent of capacity. If it does, the leaks must be located by more careful listening or by feeling along the joint.
 - (5) It should be noted that even though a system may pass the measured leakage test, a concentration of leakage at one point may result in a noisy leak which, of course, must be corrected.
3. All equipment, labor, etc., required for testing shall be provided by Contractor.

4. Testing shall be witnessed by Architect / Engineer (or designated representative) and by Owner's designated representative.
5. Submit test reports to Architect / Engineer.

END OF SECTION 23 88 00

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Common electrical installation requirements.

1.3 QUALITY ASSURANCE

- A. Contractor shall be an *Energy Efficiency Measures Installer* certified by the Illinois Commerce Commission. Application information and a listing of current certified contractors can be found at <https://www.icc.illinois.gov/authority/energy-efficiency-measures-installer>. This certification is a requirement of the energy incentives being pursued by the owner. Contractors not complying with this certification will be financially responsible for the owner's incentive monies forfeited as a result of certification non-compliance.
- B. Contractor shall assist with the owner's efforts to attain Ameren Act on Energy incentives as filed by the owner's consultant based on the design in the construction documents. Contractor shall account for the time needed to provide necessary material invoicing, shop drawings and necessary certifications/qualifications.

PART 2 - PRODUCTS – DOES NOT APPLY

PART 3 - EXECUTION

3.1 INSPECTION OF BID DOCUMENTS AND PREMISES

- A. Visit the premises, take measurements and verify all elevations shown on the drawings, inspect existing conditions and limitations, obtain first hand information necessary to submit a complete bid.
- B. Thoroughly examine the complete set of contract documents including work required by other trades. Bidders are cautioned to acquaint themselves with requirements necessitating installation work of material or equipment furnished by other contractors or the Owner.

- C. In the event of any conflict, discrepancy or inconsistency among the Contract Documents, interpretation shall be based on the following descending order or priority:
1. Specifications.
 2. Drawings, and among the drawings, the following:
 - a. as between figures given on drawings and scaled measurements, the figures shall govern;
 - b. as between large scale drawings and small scale drawings, the large scale drawings shall govern.
 3. In the event that Work is called for by the drawings but not by the specifications, or by the specifications but not by the drawings, the Contractor shall be responsible for such Work.

3.2 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping and conduit installed at required slope.
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

3.3 INTERRUPTION OF ELECTRICAL SYSTEMS AND SERVICES

- A. Do not interrupt electric systems or service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Architect or Owner no fewer than seven days in advance of proposed interruption of electrical service. Indicate:
 - a. The extent of the work to be done during the outage.
 - b. Probable length of time required for the outage.
 - c. Designed time at which the outage is to begin.
 2. Do not proceed with interruption of electrical service without Architect's or Owner's written permission.
 3. Schedule work to minimize the number and length of time of the outage(s) or interruption(s) of the various systems and services.

3.4 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Space Preference:
 - 1. Carefully verify and coordinate the location and level of all lines. Run preliminary levels and check with all other contractors so that conflict in location may be avoided.
 - 2. If conflicts occur, the following preference schedule shall be followed:
 - a. Recessed electric fixtures.
 - b. High pressure ductwork.
 - c. Sanitary drainage.
 - d. Steam condensate, hot and chilled water.
 - e. Low pressure ductwork.
 - f. Domestic water storm and vent lines.
 - g. Electric conduits.
 - 3. No other work shall have preference over plumbing lines below fixtures.
 - 4. No other work shall have preference over conduit above or below electric switchgear and above or below panels.
 - 5. No piping conveying fluids shall be provided directly over electrical or elevator equipment.
- F. Lines and Levels: Determine all grades, maintain necessary lines and levels throughout the progress of the work and assume full responsibility for their correctness. Where levels are indicated on the drawings, work shall be installed at those levels unless prior written approval to change is obtained from the Architect / Engineer.
- G. Location of Equipment: The approximate location of all equipment is shown on the drawings. The Architect / Engineer reserves the right to change the location of all equipment 5' in any direction without these changes being made the subject of an extra charge provided such changes are made before final installation.

3.5 ELECTRICAL DEMOLITION

- A. Refer to Division 1 Sections for general demolition requirements and procedures.
- B. Disconnect and remove electrical systems, equipment and components indicated to be removed.

1. Light Fixtures to be Removed: Remove light fixtures indicated to be removed along with associated, lamps, trim, supports and fixture whips.
 2. Wiring Devices to be Removed: Remove wiring devices indicated to be removed along with associated cover plates.
 3. Electrical Equipment to be Removed: Remove electrical equipment indicated to be removed along with associated supports, fittings, raceways and conductors.
 4. Motors and Mechanical Equipment to be Removed: Electrically disconnect each motor and piece of mechanical equipment indicated to be removed and remove associated raceways, conduits, devices and electrical equipment.
 5. Feeders and Branch Circuits to be Removed: Remove feeders and branch circuits indicated to be removed along with associated supports, fittings, raceway and conductors.
- C. All removed electrical equipment, devices, raceways, conductors and associated items, except as noted below, shall become property of the Contractor and shall be properly disposed of by the Contractor.
1. Turn over to the Owner and deliver to a place of storage.
- D. Fluorescent and HID lighting lamps and ballasts shall be removed from fixtures and disposed of as follows:
1. Fluorescent and HID lamps and ballasts shall be disposed of in strict adherence to waste Rule 35 III. Admin. Code Part 733.
 2. After removal from fixture, lamps and ballasts shall be stored in a safe manner to minimize breakage.
 3. Lamps and ballasts shall not be stored longer than six months from the time they are removed from service.
 4. Lamps and ballasts shall be delivered to a licensed hauler to be delivered to a lamp and ballasts recycler.
 5. Lamps and ballasts shall be transported in a safe manner to minimize breakage.
 6. Disposal of lamps and ballasts shall be in accordance with all State and local codes.
 7. Ballasts without factory label stating non-hazardous material shall be treated as a hazardous material and disposed of as stated above.
- E. Removal of existing electrical devices shall be such that all existing remaining electrical devices are kept in continuous service.
- F. Existing circuit conductors connected to outlets, boxes or fixtures being removed shall be disconnected and removed back to next active remaining device.
- G. Existing circuit conductors connected to other fixtures, devices or other electrical equipment that are not to be removed or disconnected and are passing through outlet boxes, fixtures and conduit that are being removed; shall be rerouted from remaining existing device to next remaining device as necessary to keep remaining devices in service and existing circuit conductors continuous.
- H. Where connections of existing devices cannot be made continuous with existing conduit, boxes and conductors; new raceways and conductors shall be installed from existing remaining device to next remaining device.
- I. Disconnect and remove all devices, conduit, wiring, etc., in or on the walls, ceiling, etc., to be removed. Verify all occurrences not specifically shown or noted on plans.

- J. For each item disconnected and removed, disconnect and remove defunct circuit wiring back to next active remaining device or to panel or switchboard from which the circuit originates.
- K. For each item disconnected and removed, disconnect and remove abandoned, exposed conduits, and / or conduits made exposed by demolition, back to next active remaining device or to panel or switchboard from which the circuit originates.
- L. All conditions shall be carefully field determined and verified.

3.6 CUTTING AND PATCHING

- A. Examine architectural and structural drawings to determine the general nature of the types of construction to be encountered during performance of electrical work.
- B. All cutting and patching of masonry, carpentry, steel, iron work, concrete structural work, and finished surfaces belonging to the building shall be done in order that work may be properly installed. Replace or repair all disturbed constructions or finishes to its original condition and under no condition cut structural work except upon approval of the Architect / Engineer.
- C. Cut through ceilings, floors, walls and partitions in a careful manner and fill the openings around the pipes and sleeves.
- D. Carefully coordinate locations of openings and sleeves to avoid conflict with other trades. Furnish complete information concerning locations and sizes of openings to other trades in sufficient time for inclusion on their shop drawings.
- E. Employ craftsmen and mechanics who are skilled and experienced in their respective trades to perform all cutting, fitting, matching, patch repairing, and finishing work required for installation of electrical work.
- F. Perform cutting to neat line, in a manner that will not weaken the wall, partition, or floor being cut. Cut holes in floors to neat line. Perform drilling in a manner that will not cause breaking of floor around the drilled hole.
- G. Contractor shall patch, repair and unify all work and material that is cut.

3.7 OPENINGS IN EXISTING CONSTRUCTION

- A. In existing construction, perform all cutting and patching where required in connection with the work. Match patching to existing adjacent surfaces.
- B. All cutting in existing structural elements of building shall be accomplished with hole saws. Air hammers and cutting torches are not permitted.
- C. Reinforced concrete slabs, steel joists, concrete floors and footings, or other structural work shall not be cut or disturbed in any way, unless as approved by the Architect / Engineer. The Contractor shall be held responsible for and correct all damage that he may cause.
- D. Openings between conduit and floors or walls through fire or smoke barriers shall be closed with fire stop material to maintain fire or smoke barrier rating.

- E. Fire stop material shall be Dow Corning 3-6548 Silicone RTV Foam, Chase Technology Corp. CTC PR-855 fire-resistant foam sealant, 3M CP-25 Series Caulk Fire Barrier, T & B S-101 Fire Barrier or Nelson Flameseal.

3.8 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

3.9 FIELD CORRECTIONS AND CHANGES

- A. Carefully and accurately record on field set of drawings, any deviations or changes in locations of conduit, wiring and/or equipment made in the field and shall keep the Architect / Engineer informed on all deviations and changes.
- B. At the completion of the job, furnish the Architect / Engineer three (3) complete sets (not the field set) of drawings indicating these deviations or changes. Extra sets of drawings will be provided to the contractor for this purpose. Any changes in the exterior work shall be recorded by dimension.

3.10 CLEANING UP

- A. Before work can be considered complete, clean all surfaces of all paint, plaster, mortar, labels and other stains and remove all lumps of cement. Take care not to scratch, mar, or damaged surfaces in cleaning.
- B. In case of dispute, the Owner / User may remove the rubbish and charge the cost to the one or more contractors as the Architect / Engineer may determine to be just.

3.11 TOUCH-UP PAINTING

- A. Comply with requirements in Division 9 Painting Sections for cleaning and touch-up painting.
- B. All factory applied paint finishes on all electrical items, equipment, panelboards, switchboards, fire alarm devices, etc., that is scratched or damaged shall be touched up with rust inhibitive paint to match factory applied paint.

END OF SECTION 26 05 00

SECTION 26 05 19 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. General Cable; General Cable Corporation.
 - 2. Senator Wire & Cable Company.
 - 3. Southwire Company.
 - 4. Nexans.
- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2.

2.2 CONNECTORS AND SPLICES

- 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. 3M.
 - 2. Hubbell Power Systems, Inc.
 - 3. ILSCO.
 - 4. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
 - 1. Expandable steel spring and polypropylene body type connectors and wire nuts for wire sizes up to an including No. 10 AWG.

2. Bolt type connectors or mechanical compression crimp type for wire sizes No. 8 AWG and larger. Cover connectors with three layers of 600 volt tape or heat shrinkable insulation equivalent to 150% conductor insulation.

2.3 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 NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- G. Branch Circuits below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- I. Minimum wire size shall be No. 12 except for internal fixture wire which shall be minimum size of No. 14 type SF, SFF, PF, PFF or TFN, 600 volt.

- J. All branch circuit wiring and feeder cables for circuits over 20 amps shall be sized as noted on the drawings. If size is not specifically noted, size all branch circuit wiring and feeder cables in accordance with the National Electrical Code.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Splices and taps in conductors shall be as few in number as practicable.
- D. Splices and taps shall be so made that they have an electrical resistance not in excess of that of 2' of the conductor.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- E. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- F. Neutral conductors in outlet boxes at receptacles shall be jointed and pigtailed to the outlet. The removal of a receptacle from the circuit shall not affect the continuity of the neutral conductor.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 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 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

END OF SECTION 26 05 19

SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. Dossert; AFL Telecommunications LLC.
 - 3. ERICO International Corporation.
 - 4. Fushi Copperweld Inc.
 - 5. Galvan Industries, Inc.; Electrical Products Division, LLC.
 - 6. Harger Lightning & Grounding.
 - 7. ILSCO.
 - 8. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 9. Robbins Lightning, Inc.
 - 10. Siemens Power Transmission & Distribution, Inc.

2.2 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.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. 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 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connections for Conductors and Pipes: Copper or copper alloy, pressure-type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

- B. Underground Grounding Conductors: Install bare tinned-copper conductor.
 - 1. Bury at least 24 inches below grade.
- 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: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. Separate grounding conductors are not shown on the drawings but shall be included in all raceways as set forth on the drawings.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70. Separate grounding conductors are not shown on the drawings but shall be included in all raceways as set forth on the drawings.
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.

- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches 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. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by 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 bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- F. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor 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's grounding grid or to grounding electrode external to concrete.

END OF SECTION 26 05 26

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Hangers.
 - b. Steel slotted support systems.
 - 2. Include rated capacities and furnished specialties and accessories.
- B. Delegated design submittal for piping / conduit supports shown on Sheet E11-02.
 - 1. Provide submittal including support details, layout and calculations signed and sealed by Structural Engineer.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. Flex-Strut Inc.
 - c. Unistrut; an Atkore International company.
 - 2. Material: Galvanized steel.

3. Channel Width: 1-5/8 inches.
 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 6. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.
- B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 or metal framing channel welded to structure.
 5. To Light Steel: Sheet metal screws.
 6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.
- E. Repair fireproofing damaged as a result of installing clamps or supports to structural steel.

3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Concrete bases to be 4" minimum thick unless otherwise called for on the drawings.
- C. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03.
- D. Rough up floor to assure bonding of base to floor. Anchor the base to the floor with reinforcing bars set in the floor or power driven studs. Provide two layers 6 x 6 #6 welded wire reinforcing mesh in base.
- E. Anchor equipment to concrete base as follows:
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- F. Provide concrete bases for the following floor mounted equipment:
1. Switchboards.
 2. Transformers.
 3. Generators.
 4. Fuel tanks.

3.4 PAINTING

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

- B. Prime paint all structural steel installed for pipe or equipment supports or burned by welding with one coat of rust inhibitive black paint at the time of installation.

END OF SECTION 26 05 29

SECTION 26 05 33 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Surface raceways.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

- B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

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 surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

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

1. Allied Tube & Conduit; a part of Atkore International.
2. Republic Conduit.

3. Western Tube and Conduit Corporation.

- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. FMC: Comply with UL 1; zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression.
 - 3. Expansion Fittings: Steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- H. Joint Compound for GRC: 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 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Technologies Company.
 - 2. Hubbell Incorporated.
 - 3. MonoSystems, Inc.
 - 4. RACO; Hubbell.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. 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. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep unless noted otherwise on drawings.
- I. Gangable boxes are prohibited unless noted otherwise on drawings.
- J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- K. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 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.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 3. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Damp or Wet Locations: GRC.

6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
 - a. All boxes installed in poured concrete, block, brick or tile shall be masonry type.
 - b. All multiple gang switch boxes shall be solid gang box.
 - c. The minimum size of boxes shall be 4" x 4" x 2-1/8" minimum depth. For single device installation, install square cut single device cover.
 - d. Install all device boxes with square cut device covers for number of devices required.
 - e. For multiple gang boxes installed for more than one 277 volt switch, a barrier shall be installed between each box gang.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Rigid: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Conduits and raceways shall not be supported from plumbing lines, ductwork or supports for equipment provided by other trades.
- F. Arrange stub-ups so curved portions of bends are not visible above finished slab. No non-metallic conduit shall be permitted above grade.
- G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines. In mechanical equipment rooms conduit and EMT may be exposed at the ceiling or on the walls.
- I. Support conduit within 12 inches of enclosures to which attached.

- J. Raceways Embedded in Slabs:
 - 1. There shall not be any raceways installed horizontally in concrete slabs throughout the building, except where specifically noted and detailed on the drawings.
- K. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- M. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- N. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- P. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- Q. 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.
- R. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.

- V. Expansion-Joint Fittings:
1. Install in each run of aboveground EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- 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 center 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 surfaces to provide a flat surface for a raintight connection between box 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. Locate boxes so that cover or plate will not span different building finishes.
- BB. 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.
- CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- DD. Set metal floor boxes level and flush with finished floor surface.

3.3 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 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 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.
- B. Protect work from injury by keeping all conduit and boxes capped and plugged or otherwise protected. This includes damage by freezing and / or stoppage from building materials, sand, dirt or concrete.

END OF SECTION 26 05 33

SECTION 26 05 43 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Direct-buried conduit, ducts, and duct accessories.
 - 2. Handholes and boxes.

1.3 DEFINITIONS

- A. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 2. Include accessories for manholes, handholes, boxes.
 - 3. Include warning tape.

1.5 FIELD CONDITIONS

- A. Location of Existing Buried Utilities: The contract documents do not claim to show all existing buried utilities on site.
 - 1. Contact JULIE (Joint Utility Location Information for Excavators) at 800-892-0123 at least two business days prior to any digging, excavation or boring.
 - 2. Provide services of a private locating service to identify and locate all existing utilities that could be affected by excavation and new work. Locate privately owned utilities, the Owner's utilities and all utilities that do not participate in the JULIE program.
 - 3. Repair all damage caused by the Contractor's activities promptly to the satisfaction of the Owner of the damaged utility. All such repairs shall be conducted at the sole expense of the Contractor that damaged the utility.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

- A. Comply with ANSI C2.

2.2 CONDUIT

- A. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.3 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

1. Allied Tube and Conduit: A Part of Altkove International
2. CANTEX INC.
3. ElecSys, Inc.

- B. Underground Plastic Utilities Duct: NEMA TC 6 & 8, ASTM F 512, UL 651A, Type EB-20-PVC, with matching fittings complying with NEMA TC 9 by same manufacturer as the duct.

- C. Duct Accessories:

1. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

1. Color: Gray or green.
2. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

- a. Armorcast Products Company.
- b. Carson Industries LLC.
- c. NewBasis.
- d. Olcastle Precast, Inc.
- e. Quazite: Hubbell Power Systems, Inc.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of ducts and handholes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct entrances into handholes with final locations and profiles of ducts, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 1. Units Subject to Light-Duty Pedestrian Traffic Only: Polymer concrete.

3.4 EARTHWORK

- A. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.
- C. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.5 DUCT INSTALLATION

- A. Install ducts according to NEMA TCB 2.

- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes, to drain in both directions.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- E. Duct Entrances to Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall, without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- H. Pulling Cord: Install 100-lbf-test nylon cord in empty ducts.
- I. Direct-Buried Duct Banks:
 - 1. Excavate trench bottom to provide firm and uniform support for duct bank.
 - 2. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - 3. Space separators close enough to prevent sagging and deforming of ducts, with not less than four spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
 - 4. Depth: Install top of duct bank at least 36 inches below finished grade unless otherwise indicated.
 - 5. Set elevation of bottom of duct bank below frost line.
 - 6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
 - 7. Elbows: Install manufactured duct elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - 8. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run. No plastic conduit shall be permitted above ground/grade. Couple steel conduits to ducts with

adapters designed for this purpose. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment. **(ADD 002)**

- J. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below frost line, 36" below grade.
- 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 ducts and 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.

3.7 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

SECTION 26 05 44- SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS 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 raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Grout.
 - 4. Silicone sealants.

1.3 ACTION SUBMITTALS

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

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.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc. – Innerlynx.
 - b. Metraflex Company. – Metra Seal.
 - c. Pipeline Seal and Insulator, Inc. – Link Seal

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Description: Nonshrink; 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, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

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.
- 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 raceway or cable, using silicone sealant appropriate for size, depth, and location of joint.
 - 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 annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 4. Install sleeves for all 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 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 raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve-seal system.
- G. Sleeves for Conduits Penetrating Above-Grade Fire-Rated Walls:
1. Interior Penetrations of Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using appropriate fire stop material such as 3M fire barrier CD 24WB+ or similar appropriate for size, depth, and location of joint.
 - 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.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 4. Install sleeves for all 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 above finished floor level. Install sleeves during erection of floors.
- 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION
- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 26 05 44

SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for conductors.
 - 2. Underground-line warning tape.
 - 3. Equipment identification labels.
 - 4. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

2.2 LABELS

- A. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Champion America.

- c. emedco.
 - d. Grafoplast Wire Markers.
 - e. LEM Products Inc.
 - f. Marking Services, Inc.
 - g. Panduit Corp.
- B. Snap-Around Labels for Raceways and Cables Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceways they identify, and that stay in place by gripping action.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
 - c. Panduit Corp.
- C. Self-Adhesive Labels:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A'n D Cable Products.
 - b. Brady Corporation.
 - c. Brother International Corporation.
 - d. emedco.
 - e. Grafoplast Wire Markers.
 - f. Ideal Industries, Inc.
 - g. LEM Products Inc.
 - h. Marking Services, Inc.
 - i. Panduit Corp.
 2. Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
 - a. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized to fit the cable or raceway diameter, such that the clear shield overlaps the entire printed legend.
 3. Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
 - a. Nominal Size: 3.5-by-5-inch.
- 2.3 TAPES AND STENCILS:
- A. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.

- c. emedco.

B. Underground-Line Warning Tape

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Ideal Industries, Inc.
 - c. LEM Products Inc.
 - d. Marking Services, Inc.
 - e. Reef Industries, Inc.
2. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
3. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
4. Tape Construction:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Overall Thickness: 5 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

2.4 SIGNS

A. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. inches, minimum 1/16-inch-.
 - b. For signs larger than 20 sq. inches, 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- G. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.3 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - 5) Ground: Green.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: White.
 - 5) Ground: Green with yellow stripe.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- B. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
 1. Install underground-line warning tape for direct-buried cables and cables in raceways.
- C. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm unless equipment is provided with its own identification.
 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine plastic label, punched or drilled for mechanical fasteners. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - e. Attach labels with screws and not adhesives.
 2. Equipment To Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
- b. Switchboards.
- c. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- d. Battery-inverter units.
- e. Battery racks.
- f. Power-generating units.

END OF SECTION 26 05 53

SECTION 26 05 73.16 – COORDINATION STUDIES

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 computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.3 DEFINITIONS

- A. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- D. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- F. SCCR: Short-circuit current rating.
- G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- H. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. For computer software program to be used for studies.
 - 2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

- a. Coordination-study input data, including completed computer program input data sheets.
 - b. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 1. The following are from the Coordination Study Report:
 - a. Final one-line diagram.
 - b. Final protective device coordination study.
 - c. Coordination study data files.
 - d. List of all protective device settings.
 - e. Time-current coordination curves.
 - f. Power system data.

1.6 QUALITY ASSURANCE

- A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications:
 1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. SKM Powertools.

- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. 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.

2.2 COORDINATION STUDY REPORT CONTENTS

- A. Contractor is required to provide a coordination study proving that electrical distribution system is selectively coordinated.
- B. Executive summary of study findings.
- C. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- D. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Switchgear, switchboard, motor-control center, and panelboard designations.
 - 5. Any revisions to electrical equipment required by the study.
- E. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, and ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- F. Time-Current Coordination Curves: 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:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

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 of the Work. 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. Obtain all data necessary for conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
- B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
1. Product Data for overcurrent protective devices specified in other 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. Electrical power utility impedance at the service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus (three phase and line to ground).
 5. Full-load current of all loads.
 6. Voltage level at each bus.
 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 12. Maximum demands from service meters.
 13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
 14. Motor horsepower and NEMA MG 1 code letter designation.
 15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
 16. Data sheets to supplement electrical distribution system one-line 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 root mean square (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. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
- k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Begin analysis at the service, extending down to system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
- E. Protective Device Evaluation:
 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
 3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
 4. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION 26 05 73.16

SECTION 26 05 73.19 – ARC-FLASH HAZARD ANALYSIS

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 a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- D. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- F. SCCR: Short-circuit current rating.
- G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- H. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:
 - 1. Arc-flash study input data, including completed computer program input data sheets.

2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.6 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. SKM Powertools.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Contractor to provide arc-flash hazard analysis for their proposed electrical distribution equipment.
- B. Executive summary of study findings.
- C. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- D. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- E. Study Input Data: As described in "Power System Data" Article.
- F. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- G. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- H. Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- I. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Restricted approach boundary.
 - 6. Limited approach boundary.
 - 7. Working distance.
 - 8. Incident energy.
 - 9. Hazard risk category.
 - 10. Recommendations for arc-flash energy reduction.

- J. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
- B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1. Location designation.
 - 2. Nominal voltage.
 - 3. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
 - 4. Arc flash PPE category.
 - 5. Required minimum arc rating of PPE in Cal/cm squared.
 - 6. Available incident energy.
 - 7. Working distance.
 - 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.
 - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
 - 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
 - 2. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
- D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.
- F. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on one-line diagram on Drawings. Call discrepancies to Architect's attention.
 - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other 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. Obtain electrical power utility impedance or available short circuit current at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

- A. Apply one arc-flash label on the front cover of each section of the equipment for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
 1. Low-voltage switchboard.
 2. Switchgear.
 3. mers
 4. Low voltage transformers.
 5. Panelboard and safety switch.

3.5 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

END OF SECTION 26 05 73.19

SECTION 26 09 23 – LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Standalone daylight-harvesting switching and dimming controls.
2. Indoor occupancy and vacancy sensors.
3. Low-voltage wall stations.
4. Switchbox-mounted occupancy sensors.
5. High-bay occupancy sensors.
6. Lighting contactors.
7. Emergency shunt relays.

B. Related Requirements:

1. Section 26 27 26 "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.
 - c. Daylight-harvesting controls.
 - d. Power packs.
 - e. Low-voltage switches.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.6 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: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY AND VACANCY SENSORS

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

- 1. Sensor Switch, Inc.
- 2. Hubbell Building Automation, Inc.
- 3. Philips.
- 4. Watt Stopper.

- B. General Requirements for Sensors:

- 1. Wall or Ceiling-mounted as shown on drawings, solid-state indoor occupancy or vacancy sensors.
- 2. Dual technology.
- 3. Integrated or separate power pack as needed to meet lighting control sequence.
- 4. Hardwired connection to switch.
- 5. Configured for one-pole operation.
- 6. 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.
- 7. Furnish with auxiliary dry contact closure via an SPDT, 1 amp, 40 volt relay for HVAC interface.
- 8. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A or sensor is powered from the power pack whichever best meets lighting control sequences.
- 9. Power: Low-voltage.
- 10. Power Pack: Dry contacts rated for 20-A load at 120- and 277-V ac, and for 1 hp at 120-V ac.

- a. All ceiling mounted occupancy sensors shall have auxiliary relay integral to sensor for HVAC temperature control interface.
 - b. Spaces with more than one ceiling mounted occupancy sensor shall have at least one two-pole powerpack for HVAC temperature control interface.
11. 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.
12. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
13. Bypass Switch: Override the "on" function in case of sensor failure.
14. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. 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.
 3. Standard Range Detection Coverage: Detect occupancy anywhere within a circular area of 500 sq. ft. when mounted on a 96-inch-high ceiling.
 4. Extended Range Detection Coverage: Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch high ceiling.
 5. Wall Mount Sensor Detection Coverage: Detect occupancy anywhere within a 90-degree pattern centered on the sensor over an area of 1000 square feet when mounted 96 inches above finished floor.

2.2 LOW-VOLTAGE WALL STATIONS

A. Manufacturers

1. Sensor Switch, Inc.
2. Hubbell Building Automation, Inc.
3. Philips.
4. Watt Stopper.

B. General Requirements for low-voltage wall stations: Push-Button type low-voltage wall stations shall interface with standard occupancy sensor systems and power packs in order to implement a wide range of single, bi-level and dimmable switching applications.

1. Enables occupancy sensors system to be used for manual on operation.
2. Alternative usage as override switch for auto-on applications.
3. Soft-click push-buttons with engraved identification

4. Programmable on site
5. Hard wired
6. Color: White
7. Faceplate Color: Color to match switch.
8. Available with one or more of the following options (see schedule on plans for individual switch requirements)
 - a. Two-pole, dual manual on operation
 - b. Three-way operation
 - c. 0-10 VDC dimming control

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

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

1. Sensor Switch, Inc.
2. Hubbell Building Automation, Inc.
3. Philips.
4. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired connection.

1. Manual-On Sensor Operation: Unless otherwise indicated, requires manual action to turn lights on, but no action to turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA load at 120 V, 1200-VA load at 277 V.
4. Configured for one-pole operation.
5. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 500 sq. ft.
6. Sensing Technology: Dual technology - PIR and ultrasonic.
7. Capable of controlling load in three-way application.
8. Voltage: Dual voltage - 120 and 277 V.
9. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
10. Color: White.
11. Faceplate: Color matched to switch.
12. Has ability to dim light fixtures via 0 – 10 V control.

2.4 HIGH-BAY OCCUPANCY SENSORS

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

1. Sensor Switch, Inc.
2. Hubbell.
3. Philips.
4. Watt Stopper.

- B. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
 - 3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
 - 4. Power: Low voltage.
 - 5. Operating Ambient Conditions: 32 to 149 deg F.
 - 6. Mounting: Threaded pipe.
 - 7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 8. Detector Technology: PIR.
- C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.
- D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

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 SENSOR INSTALLATION

- 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 WIRING INSTALLATION

- 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 according to conductor manufacturer's written instructions.
- D. Size conductors according to 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.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to 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.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 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 one visit 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. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."

- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 26 22 13 – LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company.
 - 3. Siemens Power Transmission & Distribution, Inc.
 - 4. Square D; by Schneider Electric.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.
- C. Obtain low voltage transformer from the same manufacturer as:
 - 1. Fusible and non-fusible switches.
 - 2. Molded case circuit breakers.
 - 3. Enclosed controllers.
 - 4. Switchboard.
 - 5. Distribution panelboards.
 - 6. Branch circuit panelboards.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 - 1. One leg per phase.

2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
 3. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
1. Coil Material: Aluminum.
 2. Internal Coil Connections: Brazed or pressure type.
 3. Terminal Connections: Bolted.
- D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- E. Enclosure: Ventilated.
1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 4. Finish: Comply with NEMA 250.
 - a. Finish Color: Gray weather-resistant enamel.
- F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- G. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

2.4 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 0553 "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems" have been met.

- E. Environment: Enclosures shall be rated for the environment in which they are located.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- B. Construct concrete bases according to Division 03 and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 26 0529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- C. Secure transformer to concrete base according to manufacturer's written instructions.
- D. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- E. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.

- f. Verify that as-left tap connections are as specified.
- g. Verify the presence of surge arresters and that their ratings are as specified.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 13

SECTION 26 24 13 - SWITCHBOARDS

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. Service and distribution switchboards rated 600 V and less.
 - 2. Disconnecting and overcurrent protective devices.
 - 3. Instrumentation.
 - 4. Control power.
 - 5. Accessory components and features.
 - 6. Identification.
 - 7. Mimic bus.

1.3 ACTION SUBMITTALS

- A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
 - 1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 6. Detail utility company's metering provisions with indication of approval by utility company.
 - 7. Include evidence of NRTL listing for series rating of installed devices.
 - 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
 - 10. Include diagram and details of proposed mimic bus.
 - 11. Include schematic and wiring diagrams for power, signal, and control wiring.

- C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components 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. Routine maintenance requirements for switchboards and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Obtain switchboards through one source from a single manufacturer.
 - 2. Obtain switchboards from the same manufacturer as:
 - a. Fusible and non-fusible switches.
 - b. Molded case circuit breakers.
 - c. Enclosed controllers.
 - d. Distribution panelboards.
 - e. Branch circuit panelboards.
 - f. Motor control centers.
 - g. Enclosed busway.
 - h. Low voltage transformers.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Handle and prepare switchboards for installation according to NECA 400 or NEMA PB 2.1.

1.7 FIELD CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is

operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

C. Unusual Service Conditions: NEMA PB 2, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton.
 2. General Electric Company.
 3. Siemens Power Transmission & Distribution, Inc.
 4. Square D.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

- 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. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Panel or fixed, individually mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- I. Indoor Enclosures: Steel, NEMA 250, Type 1 or as called for on drawings.
- J. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- K. Barriers: Between adjacent switchboard sections.
- L. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- M. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- N. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- O. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- P. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
 - 2. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
 - 3. Tin-plated aluminum feeder circuit-breaker line connections.
 - 4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 5. Ground Bus: 1/4-by-2-inch- hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 - 6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 7. Disconnect Links:
 - a. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

8. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
9. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 4. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- B. Fuses are specified in Section 262813 "Fuses."
- C. Switchboard main disconnecting means shall be equipped with Arc Energy Reduction features compliant with NEC-2014 240.87.

2.3 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
 1. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 2. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400 or NEMA PB 2.1.
 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 3. Protect from moisture, dust, dirt, and debris during storage and installation.
 4. Install temporary heating during storage per manufacturer's instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NECA 400 or NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03.
 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to switchboards.
 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, surge protection devices, and instrumentation.
1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Comply with NECA 1.

3.3 CONNECTIONS

- A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.
- B. Support and secure conductors within the switchboard according to NFPA 70.
- C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

- A. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Acceptance Testing:

- a. Test continuity of each circuit.
 - 2. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Switchboard will be considered defective if it does not pass tests and inspections.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.
10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.
- B. Source Limitations:
 1. Obtain panelboards, overcurrent protective devices, components and accessories through one source from a single manufacturer.
 2. Obtain panelboards, overcurrent protective devices, components and associates from the same manufacturer as:
 - a. Fusible and non-fusible switches.
 - b. Molded case circuit breakers.
 - c. Enclosed controllers.
 - d. Switchboards.
 - e. Motor control centers.
 - f. Enclosed busway.
 - g. Low voltage transformers.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407 or NEMA PB 1.

1.9 FIELD CONDITIONS

A. Environmental Limitations:

- 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

- 1. Ambient temperatures within limits specified.
- 2. Altitude not exceeding 6600 feet.

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

- 1. Notify Architect and Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
- 2. Do not proceed with interruption of electric service without Architect's or Construction Manager's written permission.
- 3. Comply with NFPA 70E.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

- 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

- 1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON 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. Comply with NEMA PB 1.
- C. Comply with NFPA 70.
- D. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Height: 84 inches maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- E. Incoming Mains:
 - 1. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- F. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated aluminum.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 - 5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

- G. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Tin-plated aluminum.
 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- H. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 POWER PANELBOARDS (DISTRIBUTION PANELBOARDS)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
 2. General Electric Company; GE Energy Management - Electrical Distribution.
 3. Siemens Energy.
 4. Square D.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices: Fused switches.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company; GE Energy Management - Electrical Distribution.
 - 3. Siemens.
 - 4. Square D.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company; GE Energy Management - Electrical Distribution.
 - 3. Siemens.
 - 4. Square D.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:

- 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 5. Subfeed Circuit Breakers: Vertically mounted.
 6. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application.
 - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - h. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.

2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407 or NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407 or NEMA PB 1.1.
- D. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- G. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- H. Mount panelboard cabinet plumb and rigid without distortion of box.
- I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- J. Mount surface-mounted panelboards to steel slotted supports 1 1/4 inch in depth. Orient steel slotted supports vertically.
- K. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- M. Install filler plates in unused spaces.
- N. Where flush mounted panelboards are installed, stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
- C. Acceptance Testing Preparation:
 - 1. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Panelboards will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Straight-blade convenience, hospital-grade, isolated-ground, and tamper-resistant receptacles.
 - 2. GFCI receptacles.
 - 3. Cord and plug sets.
 - 4. Toggle switches.
 - 5. Decorator-style convenience.
 - 6. Wall plates.
 - 7. Floor service outlets.

1.3 DEFINITIONS

- A. Abbreviations of Manufacturers' Names:
 - 1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
 - 2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
 - 3. Leviton: Leviton Mfg. Company, Inc.
 - 4. Pass & Seymour: Pass& Seymour/Legrand.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.
- H. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

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

- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- D. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
- B. Tamper-Resistant Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description:

1. 125 V, 20 A, straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).

2.4 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.
4. Provide 10 ft loop of cord slack at suspension point for Owner flexibility.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Single Pole:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Eaton (Arrow Hart).
 - 2) Hubbell Incorporated; Wiring Device-Kellems.
 - 3) Leviton Manufacturing Co., Inc.
 - 4) Pass & Seymour/Legrand (Pass & Seymour).

C. Key-Operated Switches: 120/277 V, 20 A.

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

- a. Eaton (Arrow Hart).
- b. Hubbell Incorporated; Wiring Device-Kellems.
- c. Leviton Manufacturing Co., Inc.
- d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 DECORATOR-STYLE DEVICES

- A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498 located adjacent to aV1, AV2 and AV3 devices shown on plan.

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

- a. Eaton (Arrow Hart).
- b. Hubbell Incorporated; Wiring Device-Kellems.
- c. Leviton Manufacturing Co., Inc.
- d. Pass & Seymour/Legrand (Pass & Seymour).

2.7 WALL PLATES

- A. Single, multi gang 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: Smooth, high-impact thermoplastic.
 3. Material for Unfinished Spaces: Galvanized steel.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

2.8 FLOOR SERVICE FITTINGS

- A. Type: Modular, above-floor, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

2.9 FINISHES

- A. Device Color:
 1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red.

- B. The Architect / Engineer reserves the right to change the color at time of shop drawing review.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

- B. Mounting Heights

1. Examine architectural details and elevations for heights indicated there. Coordinate mounting heights with wall treatment and finish.
2. Examine electrical drawings for heights indicated there.
3. Unless otherwise indicated:
 - a. Wall Switches: 48" above finished floor, except where special wall treatment requires a higher or lower setting.
 - b. Dimmer and Lighting Controls: 48" AFF, except where special wall treatment requires higher or lower setting.
 - c. Receptacles - General: 18" AFF.
 - d. Receptacles in Mechanical and Electrical Equipment Rooms: 40" AFF.
 - e. Receptacles - Exterior: 24" above finished grade.
4. Mounting heights given above shall be to the center line of the device.
5. In block walls, locate device in either bottom or top of the block course nearest to the height indicated.
6. In brick walls, mount receptacles in the horizontal position in the brick course nearest to the height indicated.
7. Where receptacles are indicated to be installed above counters, mount in the horizontal position 4" from top of back splash to bottom of box.

- C. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

- D. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

- a. Cut back and pigtail, or replace all damaged conductors.
- b. Straighten conductors that remain and remove corrosion and foreign matter.
- c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

E. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

G. Device Plates: Device plates shall fit tight against the finished walls and shall completely cover the openings in the walls for the boxes. Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening. Device plates shall be attached and adjusted so they finish straight and level.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 GROUND FAULT INTERRUPTING RECEPTACLES

- A. Where drawing or specifications call for 15 amp or 20 amp, 120 volt receptacles in the following locations, provide ground fault interrupting type receptacles.
1. Bathrooms, Restrooms and Toilet Rooms (except where toilet is located in Critical Care Patient Room of Health Care Facility).
 2. Wet locations (except where served by isolated power system).

3. Outdoors.
4. All outlets in commercial, industrial or non-dwelling unit kitchens.
5. Rooftops.
6. Within six feet of laundry, utility and wet bar sinks.
7. Within five feet of inside wall of hydro massage tub.
8. Machinery spaces of escalators, moving walks, dumb waiters and wheelchair lifts.

3.4 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
 1. Receptacles and Switches: Provide all outlet and switch coverplates with identification labels showing panelboard designation and circuit breaker number connected to device.
 - a. Normal Circuits: Black letters indicating panel and circuit number on clear background applied to front of coverplate. Minimum letter height 3/16".
 - b. Emergency Circuits: Red letter indicating panel and circuit number on clear background applied to front of coverplate. Minimum letter height 3/16".
 2. Labels shall be attached to coverplates with pressure-sensitive adhesive. Devices installed in multi-outlet, surface raceways shall be provided with labels.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Motor-control centers.
 - c. Panelboards.
 - d. Switchboards.
 - e. Enclosed controllers.
 - f. Enclosed switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 include the following:
1. Ambient temperature adjustment information.
 2. Current-limitation curves for fuses with current-limiting characteristics.
 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
 4. Coordination charts and tables and related data.

1.5 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bussmann, an Eaton business.
 2. Edison; a brand of Bussmann by Eaton.
 3. Littelfuse, Inc.
 4. Mersen USA.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
1. Type RK-1: 250 or 600-V as specified on drawings, zero- to 600-A rating, 200 kAIC, time delay.
- 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 NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Feeders, up to 600 Amp: Class RK1, time delay.
 - 2. Motor Branch Circuits: Class RK1, time delay.
 - 3. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Molded-case switches.
 - 5. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.

2. Include wiring diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Source Limitations:
 1. Obtain fusible switches and non-fusible switches from the same manufacturer as:
 - a. Enclosed controllers.
 - b. Switchboards.
 - c. Distribution panelboards.
 - d. Branch circuit panelboards.
 - e. Low voltage transformers.

- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- E. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company.
 - 3. Siemens Industry, Inc.
 - 4. Square D; by Schneider Electric.
- B. Type HD, Heavy Duty:
 - 1. Single throw.
 - 2. Three pole.
 - 3. 240 or 600-V as specified on drawings.
 - 4. 1200 A and smaller.
 - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
 - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac.
 - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company.
 - 3. Siemens Industry, Inc.
 - 4. Square D; by Schneider Electric.

- B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) or gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12) as scheduled on drawings.
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

3.3 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections for Switches:
 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

- a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify correct phase barrier installation.
 - i. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
- C. Enclosed switches will be considered defective if they do not pass tests and inspections.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 26 29 13 – MANUAL AND MAGNETIC MOTOR CONTROLLERS

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. Manual motor controllers.
 - 2. Combination full-voltage magnetic motor controllers.
 - 3. Enclosures.
 - 4. Accessories.
 - 5. Identification.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. NC: Normally closed.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SCPD: Short-circuit protective device.

1.4 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 each type of magnetic controller.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Indicate dimensions, weights, required clearances, and location and size of each field connection.

3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
 - a. Listing document proving Type 2 coordination.
7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.

1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
 - a. Routine maintenance requirements for magnetic controllers and installed components.
 - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - c. Manufacturer's written instructions for setting field-adjustable overload relays.
 - d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
 - e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 QUALITY ASSURANCE

A. Source Limitations:

1. Obtain enclosed controllers from the same manufacturer as:
 - a. Fusible and non-fusible switches.

- b. Switchboards.
- c. Distribution panelboards.
- d. Branch circuit panelboards.
- e. Low voltage transformers.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 FIELD CONDITIONS

- A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.
 - 3. The effect of solar radiation is not significant.

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 use.
- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.2 MANUAL MOTOR CONTROLLERS

- A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. General Electric Company.
 - c. Siemens Industry, Inc.
 - d. Square D; by Schneider Electric.
 - 2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
 - 3. Configuration: Nonreversing.
 - 4. Surface mounting.
 - 5. Red pilot light.

- B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. General Electric Company.
 - c. Siemens Industry, Inc.
 - d. Square D; by Schneider Electric.
 - 2. Configuration: Nonreversing.
 - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.
 - 4. Pilot Light: Red.

2.3 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

- A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. General Electric Company.
 - 3. Siemens Industry, Inc.
 - 4. Square D; by Schneider Electric.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing.
- E. Contactor Coils: Pressure-encapsulated type.
 - 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
 - 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
- G. Overload Relays:
 - 1. Thermal Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.

- e. Automatic resetting.

H. Fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.4 ENCLOSURES

A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R.
3. Kitchen or Wash-Down Areas: Type 4X, stainless steel.

B. The construction of the enclosures shall comply with NEMA ICS 6.

2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
 - a. Push Buttons: As indicated in the controller schedule.
 - b. Pilot Lights: As indicated in the controller schedule.

2.6 IDENTIFICATION

A. Controller Nameplates: Laminated acrylic plastic signs, as described in Section 26 0553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Comply with NECA 1.

- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 0529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.4 APPLICATIONS

- A. Provide separately mounted motor controllers as scheduled and shown on the drawings.
- B. Provide separate hand-off auto selector switch with maintained contacts in separate enclosure adjacent to manual starters where shown on the drawings or noted in the starter schedule.
- C. Provide combination magnetic starters for all multiple phase operated equipment, as indicated in the starter schedule. All starters shall be complete with pilot lights in cover, externally operated fused disconnect switch, fuses, and three (3) proper sized overload heaters as required. Furnish additional accessories, such as auxiliary contacts, on-off selector switches, hand-off auto selector switches and push button with the starter as indicated in the schedule. All push-button and hand-off auto selector switches shall have maintained contacts.
- D. Provide all magnetic and manual starters with properly sized overload elements.
- E. Furnish controllers with additional accessories, such as auxiliary contacts, on-off push buttons and hand-off auto selector switches with the starter as indicated in the schedule.
- F. All magnetic starters shall be provided with control coils for 120 volt control voltage. All 208 volt starters shall have a neutral in the circuit and control voltage shall be phase to neutral 120 volts.
- G. The schedule of starters as shown on the drawings shall indicate motor horse power, phase, voltage, starter size, starter type, auxiliary contacts, types of accessories; such as push buttons or hand-off-automatic switches.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Tests and Inspections:
1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify the unit is clean.
 - e. Inspect contactors:
 - 1) Verify mechanical operation.
 - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
 - f. Motor-Running Protection:
 - 1) Verify overload element rating is correct for its application.
 - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- C. Motor controller will be considered defective if it does not pass tests and inspections.

END OF SECTION 26 29 13

SECTION 26 32 13 – DIESEL EMERGENCY ENGINE GENERATORS

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 packaged diesel engine generators for emergency use with the following features:
 - 1. Diesel engine.
 - 2. Diesel fuel-oil system.
 - 3. Control and monitoring.
 - 4. Generator overcurrent and fault protection.
 - 5. Generator, exciter, and voltage regulator.
 - 6. Outdoor engine generator enclosure.
 - 7. Finishes.
- B. Related Requirements:
 - 1. Section 26 3600 "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.3 DEFINITIONS

- A. EPS: Emergency power supply.
- B. EPSS: Emergency power supply system.
- C. Operational Bandwidth: The total variation, from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include thermal damage curve for generator.
 - 3. Include time-current characteristic curves for generator protective device.
 - 4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
 - 5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

B. Field quality-control reports.

C. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

- a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- b. Operating instructions laminated and mounted adjacent to generator location.
- c. Training plan.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cummins Power Generation.
 2. Electric Power Division; Caterpillar, Inc.
 3. Generac Power Systems, Inc.
- B. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. B11 Compliance: Comply with B11.19.
- B. NFPA Compliance:
 1. Comply with NFPA 37.
 2. Comply with NFPA 70.
 3. Comply with NFPA 99.
 4. Comply with NFPA 110 requirements for Level 1 EPSS.
- C. UL Compliance: Comply with UL 2200.
- D. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: 40 to 118 deg F.
 2. Relative Humidity: Zero to 95 percent.
 3. Altitude: Sea level to 1000 feet.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- 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. EPSS Class: Engine generator shall be classified as a Class 6 according to NFPA 110.
- D. Service Load: 100 kVA.
- E. Power Factor: 0.8, lagging.
- F. Frequency: 60 Hz
- G. Voltage: 480 V ac.
- H. Phase: Three-phase, four-wire wye.
- I. Governor: Adjustable isochronous, with speed sensing.
- J. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.
- K. Capacities and Characteristics:
 - 1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
 - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- L. Engine Generator Performance:
 - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage, from no load to full load.
 - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
 - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency, from no load to full load.
 - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10 system requirements.

2.4 DIESEL ENGINE

- A. Fuel: ASTM D 975 diesel fuel oil, Grade 2-D S15.
- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid mounted.
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.
- E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.
 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.
 3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- F. Muffler/Silencer: Commercial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 1. Minimum sound attenuation of 12 dB at 500 Hz.

- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 24 V electric, with negative ground.
 - 1. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - 4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
 - 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 - 8. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: NEMA 250, Type 1 wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

- A. Comply with NFPA 30.
- B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 23 1113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.
- C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

- D. Fuel Filtering: Remove water and contaminants larger than 1 micron.
- E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:
 - 1. Tank level indicator.
 - 2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills, plus fuel for the hours of continuous operation for indicated EPSS class 6 hours continuous operation at 100% load.
 - 3. Leak detection in interstitial space.
 - 4. Vandal-resistant fill cap.
 - 5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 CONTROL AND MONITORING

- A. Automatic-Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. Provide minimum run time control set for 30 minutes, with override only by operation of a remote emergency-stop switch.
- C. Comply with UL 508A.
- D. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
- E. Control and Monitoring Panel:
 - 1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
 - 2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
 - 3. Instruments: Located on the control and monitoring panel and viewable during operation.
 - a. Engine lubricating-oil pressure gage.
 - b. Engine-coolant temperature gage.
 - c. DC voltmeter (alternator battery charging).
 - d. Running-time meter.
 - e. AC voltmeter, for each phase.
 - f. AC ammeter, for each phase.
 - g. AC frequency meter.
 - h. Generator-voltage-adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:
- a. Cranking control equipment.
 - b. Run-Off-Auto switch.
 - c. Control switch not in automatic position alarm.
 - d. Overcrank alarm.
 - e. Overcrank shutdown device.
 - f. Low water temperature alarm.
 - g. High engine temperature pre-alarm.
 - h. High engine temperature.
 - i. High engine temperature shutdown device.
 - j. Overspeed alarm.
 - k. Overspeed shutdown device.
 - l. Low-fuel main tank.
 - 1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for the duration required for the indicated EPSS class.
 - m. Coolant low-level alarm.
 - n. Coolant low-level shutdown device.
 - o. Coolant high-temperature prealarm.
 - p. Coolant high-temperature alarm.
 - q. Coolant low-temperature alarm.
 - r. Coolant high-temperature shutdown device.
 - s. EPS load indicator.
 - t. Battery high-voltage alarm.
 - u. Low-cranking voltage alarm.
 - v. Battery-charger malfunction alarm.
 - w. Battery low-voltage alarm.
 - x. Lamp test.
 - y. Contacts for local and remote common alarm.
 - z. Low-starting air pressure alarm.
 - aa. Low-starting hydraulic pressure alarm.
 - bb. Remote manual-stop shutdown device.
 - cc. Air shutdown damper alarm when used.
 - dd. Air shutdown damper shutdown device when used.
 - ee. Generator overcurrent-protective-device not-closed alarm.
- F. Common Remote Panel with Common Audible Alarm: Comply with NFPA 110 requirements. Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.
- G. Remote Alarm Annunciator: Comply with NFPA 99. An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
1. Overcrank alarm.
 2. Coolant low-temperature alarm.

3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low-fuel main tank alarm.
8. Low coolant level alarm.
9. Low-cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel-supply alarm.
17. Lamp test.
18. Low-cranking voltage alarm.
19. Generator overcurrent protective device not closed.

- H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.
- I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
1. Indicate ground fault with other engine generator alarm indications.
 2. Trip generator protective device on ground fault.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.

- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six-lead alternator.
- E. Range: Provide broad range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Dripproof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
 - 1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.

2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, tornado rated per ICC-500.
- B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads of up to 100 mph.
- C. Hinged Doors: With padlocking provisions.
- D. Space Heater: Thermostatically controlled and sized to prevent condensation.
- E. Lighting: Provide weather-resistant LED lighting with 30-fc average maintained.
- F. Muffler Location: Within enclosure.
- G. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof, tornado rated and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.
- H. Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
1. AC lighting system and connection point for operation when remote source is available.
- I. Convenience Outlets: Factory-wired GFCI. Arrange for external electrical connection.

2.10 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Architect or Construction Manager no fewer than seven working days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Architect's or Construction Manager's written permission.

3.3 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Equipment Mounting:
 - 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.
 - 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
 - 3. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 26 0548.16 "Seismic Controls for Electrical Systems."
- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.
 - 1. Piping materials and installation requirements are specified in Section 23 2113 "Hydronic Piping."
 - 2. Drain piping valves, connectors, and installation requirements are specified in Section 23 2116 "Hydronic Piping Specialties."
- F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

- A. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

3.5 IDENTIFICATION

- A. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections with assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and in "Visual and Mechanical Inspection" and "Electrical and Mechanical Tests" subparagraphs below, as specified in the NETA ATS. Certify compliance with test parameters.
 - a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with Drawings and the Specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, and grounding.
 - 4) Verify that the unit is clean.
 - b. Electrical and Mechanical Tests:
 - 1) Perform insulation-resistance tests according to IEEE 43.
 - a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
 - b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.
 - 2) Test protective relay devices.
 - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
 - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
 - 5) Perform vibration test for each main bearing cap.
 - 6) Conduct performance test according to NFPA 110.
 - 7) Verify correct functioning of the governor and regulator.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

C. Coordinate tests with tests for transfer switches, and run them concurrently.

- D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
- F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component, indicating satisfactory completion of tests.
- K. Provide either test results of sealed engineered drawings / calculations proving generator enclosure meets the requirements of ICC-500.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 26 32 13

SECTION 26 36 00 – TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes automatic transfer switches rated 600 V and less.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
 - 2. Include material lists for each switch specified.
 - 3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
 - 4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product 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. Features and operating sequences, both automatic and manual.
 - b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
1. Notify Architect or Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Architect's written permission.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.

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. Comply with NEMA ICS 1.
- C. Comply with NFPA 99.
- D. Comply with NFPA 110.
- E. Comply with UL 1008 unless requirements of these Specifications are stricter.
- F. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- G. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- H. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
- I. Neutral Terminal: Solid and fully rated unless otherwise indicated.
- J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed tape markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
 4. Accessible via front access.
- K. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cummins Power Generation.
 2. Eaton.
 3. Emerson.
 4. Generac Power Systems, Inc.
 5. Russelectric.
- B. Comply with Level 1 equipment according to NFPA 110.
- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
 2. Switch Action: Double throw; mechanically held in both directions.
 3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
 4. Conductor Connectors: Suitable for use with conductor material and sizes.
 5. Material: Tin-plated aluminum.
 6. Main and Neutral Lugs: Mechanical type.
 7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 8. Ground bar.
 9. Connectors shall be marked for conductor size and type according to UL 1008.
- D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- G. Automatic Transfer-Switch Controller Features:
1. Controller operates through a period of loss of control power.

2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is unavailable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

- B. Identify components according to Section 260553 "Identification for Electrical Systems."
- C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- D. Comply with NECA 1.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
 - 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 271500 "Communications Horizontal Cabling."
- F. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing equipment, test for compliance with requirements according to NETA ATS.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and required clearances.
 - d. Verify that the unit is clean.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Verify that manual transfer warnings are attached and visible.
 - g. Verify tightness of all control connections.
 - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

- i. Perform manual transfer operation.
 - j. Verify positive mechanical interlocking between normal and alternate sources.
 - k. Perform visual and mechanical inspection of surge arresters.
 - l. Inspect control power transformers.
 - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
 - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
3. Electrical Tests:
- a. Perform insulation-resistance tests on all control wiring with respect to ground.
 - b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
 - c. Verify settings and operation of control devices.
 - d. Calibrate and set all relays and timers.
 - e. Verify phase rotation, phasing, and synchronized operation.
 - f. Perform automatic transfer tests.
 - g. Verify correct operation and timing of the following functions:
 - 1) Normal source voltage-sensing and frequency-sensing relays.
 - 2) Engine start sequence.
 - 3) Time delay on transfer.
 - 4) Alternative source voltage-sensing and frequency-sensing relays.
 - 5) Automatic transfer operation.
 - 6) Interlocks and limit switch function.
 - 7) Time delay and retransfer on normal power restoration.
 - 8) Engine cool-down and shutdown feature.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
- a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

- f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- B. Coordinate tests with tests of generator and run them concurrently.
- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Transfer switches will be considered defective if they do not pass tests and inspections.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Prepare test and inspection reports.
- G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.
- C. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

SECTION 26 51 19 – LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Related Requirements:

- 1. Section 26 0923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample warranty.
- B. DesignLights Consortium (DLC) listing of each light fixture.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. All fixtures shall be listed with the DesignLights Consortium.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

1.10 DESIGNLIGHTS CONSORTIUM (DLC)

- A. All light fixtures submitted on this project shall be listed on the DesignLights Consortium.
- B. A/E will not accept any fixtures whose exact part number is not listed on the DesignLights Consortium. Contractor shall provide evidence of listing with submittal.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Ambient Temperature: 41 to 104 deg F.
 - 1. Relative Humidity: Zero to 95 percent.
- B. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4.
- D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- F. California Title 24 compliant.
- G. Provide luminaires from a single manufacturer for each luminaire type.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Steel:
 - 1. ASTM A 36/A 36M for carbon structural steel.
 - 2. ASTM A 568/A 568M for sheet steel.

- C. Stainless Steel:
 - 1. 1. Manufacturer's standard grade.
 - 2. 2. Manufacturer's standard type, ASTM A 240/240 M.
- D. Galvanized Steel: ASTM A 653/A 653M.
- E. Aluminum: ASTM B 209.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Lighting Fixtures: Set level, plumb and square with ceilings and walls. Install lamps in each fixture.
- C. Support all fixtures from the building structure and not from the ceiling suspension system.
- D. Support the fixtures from the bar joists, floor structure or roof structure above.
- E. When a fixture occurs under ducts, the widths of duct shall be spanned with metal framing channel suspended and supported at both ends and the fixture attached to the metal framing channel.
- F. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- G. Install lamps in each luminaire.
- H. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- I. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- J. Wall-Mounted Luminaires:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- K. Suspended Luminaires:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- L. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.

2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
- M. Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 26 51 19

SECTION 27 05 00 – 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 SUMMARY

- A. Section includes:
 - 1. Communication equipment coordination and installation.
 - 2. Common communication installation requirements.

PART 2 - PRODUCTS – DOES NOT APPLY

PART 3 - EXECUTION

3.1 INSPECTION OF BID DOCUMENTS AND PREMISES

- A. Visit the premises, take measurements and verify all elevations shown on the drawings, inspect existing conditions and limitations, obtain first hand information necessary to submit a complete bid.
- B. Thoroughly examine the complete set of contract documents including work required by other trades. Bidders are cautioned to acquaint themselves with requirements necessitating installation work of material or equipment furnished by other contractors or the Owner.
- C. In the event of any conflict, discrepancy or inconsistency among the Contract Documents, interpretation shall be based on the following descending order or priority:
 - 1. Specifications.
 - 2. Drawings, and among the drawings, the following:
 - a. as between figures given on drawings and scaled measurements, the figures shall govern;
 - b. as between large scale drawings and small scale drawings, the large scale drawings shall govern.
 - 3. In the event that Work is called for by the drawings but not by the specifications, or by the specifications but not by the drawings, the Contractor shall be responsible for such Work.

3.2 PERMITS AND FEES

- A. Obtain and pay for all permits and make all deposits necessary for the installation of the work under his contract.
- B. Where inspections of the work are required by State or local authorities, obtain certificates of inspection of the work by such authorities, and these certificates (in triplicate) shall be submitted to the Architect / Engineer.

3.3 COORDINATION

- A. Coordinate arrangement, mounting, and support of communication equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Section 07 8413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
- D. The Contractor shall review the actual conduit/pathway plans within the construction documents to ensure such installations for communication system wiring are correctly sized, adequately positioned, and have the requisite number of pull boxes for installation. The Contractor shall be responsible for all costs associated with conduit changes resulting from failure to preview and approve the conduit/pathway installed by others.

3.4 DRAWINGS

- A. All communication drawings are diagrammatic, and it is the contractor's responsibility to install a complete working system. Special care shall be exercised in the installation of the work to include all material and fittings necessary for a complete installation. Exact dimensions and locations of all outlets shall be verified on site. Before preparing a bid or proposal, the contractor shall examine all architectural and engineering drawings. If any discrepancies or details of the construction interfere with the work, the contractor shall report the same and obtain written instructions as to the changes necessary. Should he neglect to do so, he shall make the necessary changes at his own expense. Modifications of drawings are permissible if coordinated with Engineer/Architect and allowed by Owner.
- B. The drawings show only the general routing of the conduit, wiring, pathways, etc. The scale of the drawing does not permit the indication of all junction boxes, pull boxes, and fittings that may be required. The cost of such work shall be considered as part of the contract and extra payment will not be made for such work.

- C. Contractor shall refer to plans for the location of communication devices and equipment (data/voice jacks, AV devices, security devices, etc.)
- D. Refer to all architectural drawings, including casework drawings, during installation of all devices such that no conflicts will be encountered. Inform architect of any conflicts that occur before the installation of above said devices.
- E. Refer to all architectural drawings for elevations of all communication devices.

3.5 INTERRUPTION OF COMMUNICATION SYSTEM SERVICES

- A. Do not interrupt communication system services (internet, CATV, etc.) to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect or Owner no fewer than seven days in advance of proposed interruption of communication service. Indicate:
 - a. Communication system service type.
 - b. The extent of the work to be done during the outage.
 - c. Probable length of time required for the outage.
 - d. Designed time at which the outage is to begin.
 - 2. Do not proceed with interruption of communication system service without Architect's or Owner's written permission.
 - 3. Schedule work to minimize the number and length of time of the outage(s) or interruption(s) of the various systems and services.

3.6 WIRELESS ACCESS POINTS (WAPs)

- A. All existing WAPs shall be removed by the contractor, including all jacks and cabling. Replace ceiling tiles as required to match existing. Turn WAPs over to owner.
- B. All new WAPs shall be provided by the Owner and shall be installed by the Contractor. Asset tagging will be performed by the Owner prior to turning over to contractor - contractor shall sign for receipt of the WAP devices prior to installation.
- C. Contractor shall utilize grid mounting clips and cradle furnished with WAP unit for lay-in ceiling installation. For tegular ceiling installations, contractor shall provide additional rail kit as required. Install ID tag on ceiling grid and on label field on coverplate. For locations that are wall mounted, contractor shall furnish and install Oberon Series #1011-00-WH wall mount bracket or similar with data jack enclosure. The final model number shall match Owner's WAP device being provided. Coordinate final WAP model with Owner prior to ordering unit.
- D. Contractor shall furnish and install an Oberon #1024-C WAP enclosure or similar for WAPs to be installed in gymnasiums, multipurpose rooms, pools, locker rooms, o rother high abuse areas. Mount enclosure to bottom of bar joists with through bolts, washers, lock washers and lock nuts. Install ID tag on enclosure and on label field on coverplate. Where these enclosures are shown to be wall mounted, mount devices

horizontally and use Oberon -RAB right angle bracket to support these devices. Coordinate final WAP model with Owner prior to ordering unit.

- E. All WAP locations shall be provided with boxes, coverplates, jacks, cabling, patch cords and raceway as needed. All exposed conduits in gymnasiums, multipurpose rooms, pools, and other areas shall be painted out to match area.
- F. Contractor shall patch-in all WAPs into network jacks.

3.7 COMMON REQUIREMENTS FOR COMMUNICATION 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 communication 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. Space Preference:
 - 1. Carefully verify and coordinate the location and level of all lines. Run preliminary levels and check with all other contractors so that conflict in location may be avoided.
 - 2. If conflicts occur, the following preference schedule shall be followed:
 - a. Recessed electric fixtures.
 - b. High pressure ductwork.
 - c. Sanitary drainage.
 - d. Steam condensate, hot and chilled water.
 - e. Low pressure ductwork.
 - f. Domestic water storm and vent lines.
 - g. Electric conduits.
 - 3. No other work shall have preference over plumbing lines below fixtures.
 - 4. No other work shall have preference over conduit above or below electric switchgear and above or below panels.
 - 5. No piping conveying fluids shall be provided directly over communication equipment.
- F. Lines and Levels: Determine all grades, maintain necessary lines and levels throughout the progress of the work and assume full responsibility for their correctness. Where levels are indicated on the drawings, work shall be installed at those levels unless prior written approval to change is obtained from the Architect / Engineer.
- G. Location of Equipment: The approximate location of all equipment is shown on the drawings. The Architect / Engineer reserves the right to change the location of all equipment 5' in any direction without

these changes being made the subject of an extra charge provided such changes are made before final installation.

3.8 DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect and remove communication systems, equipment and components indicated to be removed.
 - 1. Communication device to be Removed: Remove communication device indicated to be removed along with associated, trim, supports and fixture whips.
 - 2. Communication Equipment to be Removed: Remove communication equipment indicated to be removed along with associated supports, fittings, raceways and conductors.
 - 3. Communication wiring to be Removed: Remove wiring indicated to be removed along with associated supports, fittings, raceway and conductors.
- C. All removed communication equipment, devices, raceways, conductors and associated items, unless noted otherwise on drawings, shall become property of the Contractor and shall be properly disposed of by the Contractor.
- D. Removal of existing communication devices shall be such that all existing remaining communication devices are kept in continuous service.
- E. Existing system wiring connected to communication devices being removed shall be disconnected and removed back to next active remaining device.
- F. Existing communication system wiring connected to other devices or other communication equipment that are not to be removed or disconnected and are passing through junction boxes and conduit that are being removed; shall be rerouted from remaining existing device to next remaining device as necessary to keep remaining devices in service and existing system wiring continuous.
- G. Where connections of existing devices cannot be made continuous with existing conduit, boxes and wiring; new raceways and wiring shall be installed from existing remaining device to next remaining device.
- H. Disconnect and remove all devices, conduit, wiring, etc., in or on the walls, ceiling, etc., to be removed. Verify all occurrences not specifically shown or noted on plans.
- I. For each item disconnected and removed, disconnect and remove defunct communication system wiring back to next active remaining device or to communication equipment from which the circuit originates.
- J. For each item disconnected and removed, disconnect and remove abandoned, exposed conduits, and / or conduits made exposed by demolition, back to next active remaining device or to communication equipment from which the circuit originates.
- K. All conditions shall be carefully field determined and verified.
- L. Provide all abandoned ceiling outlets, switch boxes and outlet boxes with blank coverplates.

3.9 OPENINGS IN NEW CONSTRUCTION

- A. Openings required in new construction for communication work will be provided by the Contractor at the request of and in accordance with information furnished by the Contractor. The Contractor will advise the Contractor in advance so that he may lay out the required openings. If said Contractor fails to lay out required openings, he shall be financially responsible for the necessary cutting, patching and repairing. The patching and repairing will be done by the Contractor.

3.10 CUTTING AND PATCHING

- A. Examine architectural and structural drawings to determine the general nature of the types of construction to be encountered during performance of communication work.
- B. All cutting and patching of masonry, carpentry, steel, iron work, concrete structural work, and finished surfaces belonging to the building shall be done in order that work may be properly installed. Replace or repair all disturbed constructions or finishes to its original condition and under no condition cut structural work except upon approval of the Architect / Engineer.
- C. Cut through ceilings, floors, walls and partitions in a careful manner and fill the openings around the pipes and sleeves.
- D. Carefully coordinate locations of openings and sleeves to avoid conflict with other trades. Furnish complete information concerning locations and sizes of openings to other trades in sufficient time for inclusion on their shop drawings.
- E. Employ craftsmen and mechanics who are skilled and experienced in their respective trades to perform all cutting, fitting, matching, patch repairing, and finishing work required for installation of communication work.
- F. Perform cutting to neat line, in a manner that will not weaken the wall, partition, or floor being cut. Cut holes in floors to neat line. Perform drilling in a manner that will not cause breaking of floor around the drilled hole.
- G. Contractor shall patch, repair and unify all work and material that is cut.

3.11 OPENINGS IN EXISTING CONSTRUCTION

- A. In existing construction, perform all cutting and patching where required in connection with the work. Match patching to existing adjacent surfaces.
- B. All cutting in existing structural elements of building shall be accomplished with hole saws. Air hammers and cutting torches are not permitted.
- C. Reinforced concrete slabs, steel joists, concrete floors and footings, or other structural work shall not be cut or disturbed in any way, unless as approved by the Architect / Engineer. The Contractor shall be held responsible for and correct all damage that he may cause.
- D. Openings between conduit and floors or walls through fire or smoke barriers shall be closed with fire stop material to maintain fire or smoke barrier rating.

- E. Fire stop material shall be Dow Corning 3-6548 Silicone RTV Foam, Chase Technology Corp. CTC PR-855 fire-resistant foam sealant, 3M CP-25 Series Caulk Fire Barrier, T & B S-101 Fire Barrier or Nelson Flameseal.

3.12 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communication installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

3.13 FIREPROOFING REPAIR

- A. Install all hangers, inserts, supports, anchorages, etc., prior to installation of fireproofing materials. Do not remove or damage fireproofing on roof deck, roof beams, roof framing, floor beams of other floor framing members, columns, or wind bracing during installation of any communication work. If fireproofing is damaged or is removed, repair or replace to satisfaction of Architect / Engineer and at no additional expense to Owner.

3.14 EXCAVATION AND BACKFILLING

- A. The Contractor is to call JULIE (Joint Utility Location Information for Excavators) at 800-892-0123 at least two business days prior to any digging, excavation, boring, or other such work. The contractor shall recognize that the JULIE locating service locates only those utilities that participate in the JULIE program and that non-participating utilities, privately-owned utilities, and the Owner's own services will not be located by JULIE. The contractor shall also recognize that the contract documents do not claim to show all utilities existing on the site. In addition to JULIE, the contractor shall provide, at their expense, the services of a private locating service to identify and locate all utilities, public and private, that could be affected by the contractor's work. The contractor shall repair all damage caused by the Contractor's activities promptly to the satisfaction of the owner of the damaged utility. All such repairs shall be conducted at the sole expense of the Contractor that damaged the utility.
- B. Conduct all excavations so that no personnel shall be endangered and no building walls or footings shall be disturbed or injured.
- C. Excavate to dimensions and elevations required for work.
- D. Remove any old foundations, building construction, and other materials concealed beneath present grade, where required to execute work, and as indicated.
- E. If undesirable material is encountered during excavation, remove and replace material as directed by Architect / Engineer.
- F. Properly level off bottoms of all excavations.
- G. Remove all rocks, lumps, frozen ground, soft or wet material, vegetation, and other foreign material upon which fill is to be placed.
- H. Scarify top 12" (300 mm) of earth and compact to 95% of maximum dry density.

- I. Place fill material in 9" lifts and compact each lift to 90%.
- J. Maintain between 0% below and 3% above optimum moisture content during compaction.
- K. Compact fill and backfill using suitable mechanical tamping equipment to obtain specified density.
 - 1. Use mechanical hand tampers for filling and backfilling next to walls.
 - 2. Compact granular fill using vibratory methods.
- L. Do not permit water to accumulate or remain in trench or other excavation that is a part of this contract. Dispose of water withdrawn from excavations in a manner that will not cause injury to public health, public or private property, or to the work already completed or in progress.
- M. All backfill material under buildings, sidewalks, streets, curbs and within 5' of footings shall be sand and gravel, free from cinders, ashes, refuse, vegetable or organic material, boulders, large rocks or stones. Where a utility passes under a building footing, backfill material shall be concrete up to footing bearing surface.
- N. Load excavated materials which are to be replaced with sand and gravel backfill, directly from the trench into trucks, remove from the construction area and properly dispose of if where directed.
- O. Extreme caution must be used in excavating for new underground services to avoid all damage to existing underground utilities in the working area. Confirm where possible, the exact location of all existing utilities. In the event of a break in an existing utility main or service, immediately notify an official from the utility interrupted and lend all possible assistance in restoring services cut. Also, assume costs or claims connected with the interruption and repair of such service.
- P. Excavate the trenches to the depth required so as to provide a uniform and continuous bearing and support for the pipe on solid undisturbed ground or compacted fill.
- Q. Wherever excavations are made through streets, sidewalks, parking areas, curbs or other finished surfaces, replace such surfaces with material to match existing surfaces. Where reinforcing steel in concrete is required, install it in a manner similar to that used in existing surfaces.
- R. If it is necessary to drive trucks or equipment over sidewalks, pavement, streets, and curbs, take care to protect same from damage. If such surfaces are damaged, replace same with new materials, same type and thickness and in the manner as the original.
- S. Reuse original surface materials if, in the opinion of the Architect / Engineer, they are suitable for use in restoration.
- T. Excavated material which is to be reused in backfilling or restoring the surface shall be piled in a manner that will not endanger the work and will avoid obstructing sidewalks, driveways or traffic lanes which are to be maintained during construction.
- U. Keep all excavated topsoil separated from excavation soil. Stockpile sufficient topsoil to provide 6" top soil at all graded areas. Provide any additional soil from off-site source if required.

3.15 FIELD CORRECTIONS AND CHANGES

- A. Carefully and accurately record on field set of drawings, any deviations or changes in locations of conduit, wiring and/or equipment made in the field and shall keep the Architect / Engineer informed on all deviations and changes.
- B. At the completion of the job, furnish the Architect / Engineer three (3) complete sets (not the field set) of drawings indicating these deviations or changes. Extra sets of drawings will be provided to the contractor for this purpose. Any changes in the exterior work shall be recorded by dimension.

3.16 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Before final acceptance of communication installations, provide to the Architect / Engineer three (3) bound copies of a complete set of operating and maintenance instructions and procedures for all communication systems and equipment furnished under this contract.
- B. Prepare a complete file of maintenance and operating instructions which covers all communication systems and equipment listed in the section entitled "Submittals".
- C. Data shall be placed in an 8-1/2" x 11" slide hinge, heavy duty, three-post type, stiff cover binder. Each completed binder shall not exceed 3-1/2" in thickness. Label binder as follows:

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- D. Data shall include a complete table of contents, tabs, final approved shop drawings, wiring diagrams, manufacturer's operating and maintenance instructions, catalog brochure information, replacement parts lists, name, address and telephone number of nearest stocking supply house.
- E. Drawings shall be neatly folded to approximately 8-1/2" x 11" size and inserted individually into 8-1/2" x 11" sheet protectors which shall be properly punched and inserted into the binder.
- F. All material relative to the equipment for one system (i.e.; network wiring, paging, local sound systems, etc.) shall be filed behind a clearly labeled filing tab. The following information shall be typed on the filing tab page: Item, Manufacturer, Contractor's Order Number, Supplier's Order Number, Manufacturer's Order Number.
- G. Three completed files shall be submitted for review prior to job completion. Final payments will not be certified until the maintenance manuals have been received and reviewed.
- H. Authorized manufacturer's personnel shall instruct (to the Owner's satisfaction) all personnel designated by the Owner in the use of equipment and systems as listed in the section entitled "Submittals".
- I. Provide a minimum of two man days in two trips to the job before the job is accepted for the instruction and training of the Owner's representative in the operation and maintenance of the complete communication system.
- J. The above does not relieve the contractor of his responsibility of making service calls due to any defect which may develop with systems or equipment during the guarantee period nor shall these service calls be

included as part of instruction time. Specific requirements in specifications for factor service representatives is also in addition to above requirements.

3.17 CLEANING UP

- A. Before work can be considered complete, clean all surfaces of all paint, plaster, mortar, labels and other stains and remove all lumps of cement. Take care not to scratch, mar, or damaged surfaces in cleaning.
- B. In case of dispute, the Owner / User may remove the rubbish and charge the cost to the one or more contractors as the Architect / Engineer may determine to be just.

3.18 TOUCH-UP PAINTING

- A. Comply with requirements in Division 9 Painting Sections for cleaning and touch-up painting.
- B. All factory applied paint finishes on all communication devices and equipment that is scratched or damaged shall be touched up with rust inhibitive paint to match factory applied paint.

END OF SECTION 27 05 00

SECTION 27 05 26 – 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 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding labeling.

1.3 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. TGB: Telecommunications grounding busbar.
- C. TMGB: Telecommunications main grounding busbar.
- D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. BCT, TMGB, TGBs, and routing of their bonding conductors.
- B. Qualification Data: For installation supervisor, and field inspector.
- C. Field quality-control reports.

1.6 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.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of BICSI Technician or Licensed Electrician Level Installer, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as a designer RCDD or a Licensed Electrician to perform the on-site inspection.

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:
 - 1. General Cable: General Cable Corporation.
 - 2. Senator Wire & Cable Company.
 - 3. Southwire Company.
 - 4. Nexans.
 - 5. Republic Wire, Inc.
- 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. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

2.3 CONNECTORS

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

1. [Chatsworth Products, Inc.](#)
2. [Harger Lightning & Grounding.](#)
3. [Hubbell Incorporated \(Construction and Energy Group\).](#)
4. [Panduit Corp.](#)

B. 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.

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, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

2.4 GROUNDING BUSBARS

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

1. [Chatsworth Products, Inc.](#)
2. [Harger Lightning & Grounding.](#)
3. [Panduit Corp.](#)

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches by 20 inches. The busbar shall be NRTL listed for use as TMGB 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 a 4-inch 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 by 12 inches. 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 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.
- D. 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 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 long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 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-607-B.

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.

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. Conductor Terminations and Connections:
1. Equipment Grounding Conductor Terminations: Bolted connectors.
- C. Conductor Support:
1. Secure grounding and bonding conductors at intervals of not less than 36 inches.
- D. 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 intervals.
 4. Install grounding and bonding conductors in 3/4-inch 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 a 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.
- 3.3 GROUNDING BUSBARS
- A. Install busbars horizontally, 12 inches above finished floor unless otherwise indicated.
- 3.4 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. Pretwist the conductor.
 3. Apply an antioxidant compound to all bolted and compression connections.
 - D. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. The telecommunications backbone conductor size shall be No. 3/0 AWG unless otherwise indicated.

- E. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- F. 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.
- G. Electrical Power Panelboards: Bond each TGB to the ground bar of the panelboard.
- H. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
- I. 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.

3.5 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
 - 2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.

3.6 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 by 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 in each TGB. Maximum acceptable ac current level is 1 A.

- C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, 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 27 05 26

SECTION 27 05 28 - PATHWAYS 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 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Optical-fiber-cable pathways and fittings.
 - 3. Hooks.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid conduit.
- B. IMC: Intermediate metal conduit.
- C. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Boxes, enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Tube & Conduit; a part of Atkore International.
 - 2. Republic Conduit.
 - 3. Western Tube and Conduit Corporation.
- C. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 2. Comply with TIA-569-D.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: 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.

2.2 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum riser or general-use installation as required.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alpha Wire.
 2. Carlton; a brand of Thomas & Betts Corporation.
 3. Dura-Line.
 4. Endot Industries Inc.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

2.3 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. MonoSystems, Inc.
 2. Panduit Corp.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.
- E. Galvanized steel.
- F. J shape.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Crouse-Hinds, an Eaton business.
 2. Hubbell Incorporated.
 3. MonoSystems, Inc.
 4. Thomas & Betts Corporation; A Member of the ABB Group.
- C. General Requirements for Boxes, Enclosures, and Cabinets:
1. Comply with TIA-569-D.
 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
 4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep unless noted otherwise on drawings.
 5. Gangable boxes are prohibited.
- D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- E. Metal Floor Boxes:
1. As shown on floor box schedule on drawings.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Large Capacity Wall Boxes:
1. Four-inch-deep gangable steel junction box.
 2. Multiple knock-outs: 1/2", 3/4", 1", 1-1/4", 1-1/2" & 2".
 3. Dividable with separate divider plate.
 4. Model:
 - a. Two-Gang: Hubbell #HBL985
 - b. Three-Gang: Hubbell #HBL986
 - c. Four-Gang: Hubbell #HBL987
- H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, **Type 1**, with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- I. Cabinets:
1. NEMA 250, **Type 1** galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
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.

2.5 BOX FOR FLAT PANEL DISPLAY

- A. Recessed, steel box with paintable white trim plate.
- B. Box shall have divider plates for simultaneous line- and low-voltage installations.
- C. Installation:
 1. Box shall be suitable for new and existing construction.
 2. Box shall have ability to be screw to wood or metal studs for new-construction installations.
 3. Box shall be equipped with mounting wings to securely hold boxes in wall for existing-construction installations.
- D. Box shall be UL listed.
- E. Box shall be:
 1. Arlington Industries, Inc. # TVBS505 or similar for two-gang box.
 2. Arlington Industries, Inc. # TVBS507 or similar for three-gang box.
 3. Arlington Industries, Inc. # TVBS613 or similar for four-gang box.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Indoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, communications-cable pathway.
 5. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, communications-cable pathway.
 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic units in institutional and commercial kitchens and damp or wet locations.
- B. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

- C. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
- D. Install surface pathways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-D.
 - 4. NECA 101
 - 5. NECA 102.
 - 6. NECA 105.
 - 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Conduits and raceways shall not be supported from plumbing lines, ductwork or supports for equipment provided by other trades.
- G. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- H. Complete pathway installation before starting conductor installation.
- I. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- J. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- K. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines. In mechanical equipment rooms, conduit may be exposed at the ceiling or on the walls.
- L. Support conduit within 12 inches of enclosures to which attached.
- M. Raceways Embedded in Slabs:

1. There shall not be any raceways installed horizontally in concrete slabs throughout the building, except where specifically noted and detailed on the drawings.
- N. Stub-ups to Above Recessed Ceilings:
1. Use EMT or RMC for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- S. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 3. 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. 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 of slack. The lowest point of the cables shall be no less than 6 inches 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 5 feet o.c.
 5. Provide a hook at each change in direction.
- U. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- V. 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 raintight connection between box and cover plate or supported equipment and box.

- W. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- X. 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.
- Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- Z. Set metal floor boxes level and flush with finished floor surface.
- AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 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 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 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 27 05 28

SECTION 27 05 29 – HANGERS AND SUPPORTS 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 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Steel slotted support systems for communication raceways.
- 2. Conduit and cable support devices.
- 3. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.

1.3 ACTION SUBMITTALS

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

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
- 2. Include rated capacities and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

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

- a. B-line, an Eaton business.
 - b. Flex-Strut Inc.
 - c. Unistrut; Part of Atkore International.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 4. Channel Width: 1-5/8 inches.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 7. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Anchors using explosive charges to drive inserts into concrete shall not be used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) B-line, an Eaton business.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101.
 5. NECA 105.
- B. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Use expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27).
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 PAINTING

- A. Touchup: Comply with requirements in Section 09 9113 "Exterior Painting", Section 09 9123 "Interior Painting" and Section 09 9600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 27 05 29

SECTION 27 05 44 – SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS 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. Round sleeves.
 - 2. Sleeve seal systems.
 - 3. Grout.
 - 4. Foam sealants.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

- A. Wall Sleeves, Steel:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. CCI Piping Systems.
 - c. Flexicraft Industries.
 - 2. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.
- B. Sheet Metal Sleeves, Galvanized Steel, Round:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Benefast.
 - 2. Description: Galvanized-steel sheet; thickness not less than 0.0239-inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 SLEEVE SEAL SYSTEMS

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

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

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.4 FOAM SEALANTS

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

1. Dow Chemical Company (The).

B. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. 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 space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and pathway or cable, using foam sealant appropriate for size, depth, and location of joint.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed.
 4. Install sleeves for all 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 above finished floor level. Install sleeves during erection of floors.
- C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- E. Underground, Exterior-Wall and Floor Penetrations:
1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
 2. Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.
- F. Sleeves for Conduits Penetrating Above-Grade Fire-Rated Walls:
1. Interior Penetrations of Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using appropriate fire stop material such as 3M fire barrier CD 24WB+ or similar appropriate for size, depth, and location of joint.
 - 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.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for all 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 above finished floor level. Install sleeves during erection of floors.

3.2 INSTALLATION OF SLEEVE SEAL SYSTEMS

- 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.

END OF SECTION 27 05 44

SECTION 27 05 53 – IDENTIFICATION 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 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for labels and signs.
 - 2. Labels.
 - 3. Signs.
 - 4. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Champion America.
 - c. LEM Products Inc.
 - d. Panduit Corp.

2.4 SIGNS

- A. Laminated-Acrylic or Melamine-Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.

- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- H. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 - 3. Provide label 6 inches from cable end.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- C. Faceplates: Label individual jacks within each faceplates with self-adhesive labels. Each faceplate shall be labeled with circuit as shown on plan.
- D. Equipment Room Labeling:
 - 1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 - 2. Patch Panels: Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.
- E. Backbone Cables: Label each cable with a vinyl-wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- F. Horizontal Cables: Label each cable with a vinyl-wraparound labeling circuit as shown on plans.
- G. Equipment Identification Labels:
 - 1. Indoor Equipment: Laminated-acrylic or melamine-plastic sign.
 - 2. Equipment to Be Labeled:
 - a. Communications cabinets and racks.

END OF SECTION 27 05 53

SECTION 27 11 00 - 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 SUMMARY

A. Section Includes:

- 1. Backboards.
- 2. Boxes, enclosures, and cabinets.
- 3. Power strips.

B. Related Requirements:

- 1. Section 27 1323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
- 2. Section 27 1513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 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.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
- 2. 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. 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 grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. 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.

1.6 QUALITY ASSURANCE

A. A single installer shall be responsible for the procurement and installation of all wiring, cabling and accessories that make up the designed I.T. network described in these construction documents. This includes, but is not limited to: network racks, patch panels, rack-mounted power supplies, fiber optic cabling, and copper horizontal cabling.

1. Separate contractors, sub-contractors, vendors, etc. shall not be permitted to install network wiring for their own IP-based systems, for example. This wiring shall only be permitted to be installed by the project's primary division 27 wiring installer.

PART 2 - PRODUCTS

2.1 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.
- B. Backboard Paint: Light-colored interior latex paint.

2.2 BOXES, ENCLOSURES, AND CABINETS

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

1. Hubbell Incorporated.
2. MonoSystems, Inc.
3. Spring City Electrical Manufacturing Company.
4. Thomas & Betts Corporation; A Member of the ABB Group.

- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- F. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- G. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- H. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.

2.3 POWER DISTRIBUTION UNITS – RACK MOUNTED

- A. MANUFACTURERS
 - 1. Eaton
 - 2. Schneider Electric
 - 3. Legrand
- B. Features:
 - 1. Color-coded outlet sections
 - 2. Rack mountable
- C. Orientation: Vertical
- D. Input
 - 1. Voltage: **208V, Single-Phase**
 - 2. Plug: **NEMA L6-30P**
- E. Outputs
 - 1. Voltage: **120V, Single-Phase**
 - 2. Plugs: 24 5-20R
 - 3. Current Rating: 24A

PART 3 - EXECUTION

3.1 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 6 inches to 8 feet, 6 inches 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-D.

END OF SECTION 27 11 00

SECTION 27 11 16 - COMMUNICATIONS 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 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. 19-inch freestanding and wall-mounted equipment cabinets.
3. Grounding.
4. Labeling.

B. Related Requirements:

1. Section 27 1110 "Communications Equipment Room Fittings" for backboards and accessories.
2. Section 27 1323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
3. Section 27 1513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 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.

1.4 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for 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.

1.5 QUALITY ASSURANCE

- A. A single installer shall be responsible for the procurement and installation of all wiring, cabling and accessories that make up the designed I.T. network described in these construction documents. This includes, but is not limited to: network racks, patch panels, rack-mounted power supplies, fiber optic cabling, and copper horizontal cabling.
1. Separate contractors, sub-contractors, vendors, etc. shall not be permitted to install network wiring for their own IP-based systems, for example. This wiring shall only be permitted to be installed by the project's primary division 27 wiring installer.

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. Description: Two- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden Inc.
 2. CommScope, Inc.
 3. Hubbell Premise Wiring.
 4. Legrand NA (Middle Atlantic Products Division).

5. [Panduit Corp.](#)

C. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Floor-Mounted Racks (two-post racks):

1. Load Rating: 1000 lb.
2. Number of Rack Units per Rack: 45.
 - a. Numbering: Every five rack units, on interior of rack.
3. Threads: 12-24.
4. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
5. Base shall have a minimum of four mounting holes for permanent attachment to floor.
6. Top shall have provisions for attaching to cable tray or ceiling.
7. Self-leveling.

E. 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 19-INCH EQUIPMENT CABINETS

A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.

B. [Manufacturers](#): Subject to compliance with requirements, provide products by one of the following:

1. [Belden Inc.](#)
2. [CommScope, Inc.](#)
3. [Hubbell Premise Wiring.](#)
4. [Legrand NA \(Middle Atlantic Products Division\).](#)
5. [Panduit Corp.](#)

C. General Cabinet Requirements:

1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

4. Color: Black.

D. Modular Freestanding Cabinets:

1. Overall Depth: 29 inches.
2. Load Rating: 3000 lb.
3. Number of Rack Units: 45.
 - a. Numbering: Every five rack units, on interior of rack.
4. Threads: 12-24.
5. Removable and lockable side and top panels.
6. Bi-folding, hinged and lockable front and rear doors. Large Single Doors not allowed.
7. Adjustable feet for leveling.
8. Screened ventilation openings in roof and rear door.
9. Cable access provisions in roof and base.
10. TGB.
11. Roof-mounted, 550-cfm fan with filter.
12. All cabinets keyed alike.

E. Modular Wall Cabinets:

1. Depth: 29 inches.
2. Load Rating: 200 lb.
3. Number of Rack Units: 12.
4. Threads: 12-24.
5. Lockable front doors.
6. Louvered side panels.
7. Cable access provisions top and bottom.
8. Grounding lug.
9. Roof-mounted, 250-cfm fan.
10. All cabinets keyed alike.

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 top of each relay rack, with a minimum height of two rack units each.

2.4 GROUNDING

- A. 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. Pre-drilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.

2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch 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 TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.
- B. Bond rack-mounted TGB to IDF / MDF ground bar with #3/0 AWG copper conductor.

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.

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 of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor to network cabinet / rack.
 - 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. Labels shall be machine printed.

END OF SECTION 27 11 16

SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER 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 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
 - 2. 9/125 micrometer single-mode, indoor-outdoor optical fiber cable (OS2).
 - 3. Optical fiber cable connecting hardware, patch panels, and cross-connects.
 - 4. Cabling identification products.

1.3 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. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

- A. Optical fiber 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.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. Cabling administration drawings and printouts.

3. Wiring diagrams to show typical wiring schematics including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
4. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

C. Optical fiber cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

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. Patch-Panel Units: One of each type.
 2. Plugs: Ten of each type.
 3. Jacks: Ten of each type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

- C. A single installer shall be responsible for the procurement and installation of all wiring, cabling and accessories that make up the designed I.T. network described in these construction documents. This includes, but is not limited to: network racks, patch panels, rack-mounted power supplies, fiber optic cabling, and copper horizontal cabling.
 - 1. Separate contractors, sub-contractors, vendors, etc. shall not be permitted to install network wiring for their own IP-based systems, for example. This wiring shall only be permitted to be installed by the project's primary division 27 wiring installer.

1.10 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.

1.11 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.

1.12 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.13 WARRANTY

- A. Provide a comprehensive cable/premise wiring device warranty from manufacturer of communication device system for no less than 25 years. This shall include a warranty on all parts and labor:
 - 1. The cabling/premise wiring device warranty and system performance guarantee program shall warrant the structured cabling system is free from defects in material and workmanship and will support any current or future Category-6A system applications ratified by IEEE, ANSI or ISO that is developed for an ANSI/TIA/EIA-568-D compliant structured cabling system for a 25-year period from date of registered installation. This warranty shall also include a warranty covering all components (work area outlets, horizontal cable, connecting hardware in the horizontal cross-connect, the equipment cord at the work area, and the patch cord in the horizontal cross-connect). All devices must be manufactured by warranty provider.
 - 2. Contractor must be a Certified Installer and accredited Certified Installer for the manufacturer of product being installed, as approved by Owner.
- B. Provide a one (1) year warranty on all other associated equipment not covered under warranty indicated above.

- C. The contractor shall provide a minimum one (1) year warranty for all parts and labor on each phase of construction, based upon the substantial completion date established for each phase of construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)

- A. Description: Multimode, 50/125-micrometer, 12-fiber, nonconductive, tight buffer, optical fiber cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Panduit.
- C. Standards:
 - 1. Comply with ICEA S-83-596 for mechanical properties.
 - 2. Comply with TIA-568-C.3 for performance specifications.
 - 3. Comply with TIA-492AAAC for detailed specifications.
- D. Cable shall be aluminum armored type.
- E. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
- F. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
- G. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.
- H. Jacket:
 - 1. Jacket Color: Aqua.
 - 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
 - 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
- I. 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:
 - 1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

2.3 OPTICAL FIBER CABLE HARDWARE

- A. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
 - 1. Panduit.
- B. Standards:
 - 1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
 - 2. Comply with TIA-568-C.3.
- C. Patch Panels: Modular panels housing multiple-numbered, duplex MM, LC cable connectors with clear glass door and sliding interior tray.
 - 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
- D. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.
- E. Connector Type: Type LC complying with TIA-604-10-B, connectors.
- F. Plugs and Plug Assemblies:
 - 1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
 - 2. Insertion loss not more than 0.75 dB.
 - 3. Marked to indicate transmission performance.
- G. Jacks and Jack Assemblies:
 - 1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
 - 2. Insertion loss not more than 0.75 dB.

2.4 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

2.5 IDENTIFICATION PRODUCTS

- 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.

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. 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.
- 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.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.
- B. Examine pathway elements intended for cables.
 - 1. Verify proposed routes of pathways. Check raceways, cable trays, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with EMI clearance requirements. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 2. Prepare wall penetrations and verify that penetrations of rated fire walls are made using products labeled for type of wall penetrated.
 - 3. Identify plan to support cables and raceways in suspended ceilings. Verify weight of individual types and sizes of cables. Verify that load capacity of cable support structures is adequate for each pathway.
 - 4. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Verify that surfaces are ready and clean to receive work.
- D. Verify that quantity and sizes of boxes/conduit are acceptable for installation of jacks and cabling.
- E. Make contractor and architect aware of any condition on-site that may interfere or cause damage to installation of system.
- F. Beginning installation means installer accepts existing conditions.
- G. Installer shall coordinate work with all tradesmen.

- H. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.
 - I. Comply with TIA/EIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
 - J. Comply with requirements in Division 26 Sections for installation of conduits and wireways.
 - K. General Requirements for Optical Fiber Cabling Installation:
 - 1. Comply with TIA-568-C.1 and TIA-568-C.3.
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 9. In the communications equipment room, provide a 10-foot-long service loop on each end of cable.
 - 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 - 11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
 - L. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
 - 3. Cable shall be installed in pathway as listed in Section 270528 - Pathways For Communications Systems.
- 3.4 FIRESTOPPING
- A. Comply with requirements in Section 078413 "Penetration Firestopping."
 - B. Comply with TIA-569-D, Annex A, "Firestopping."
 - C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

- A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-B and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. 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. 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, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- B. Cable and Wire Identification:
 - 1. Label each cable within 4 inches 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. 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.
- C. 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 606-B, for the following:
 - 1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect 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-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Optical Fiber Cable Tests:

- a. Test instruments shall meet or exceed applicable requirements in TIA-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 one direction according to TIA-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 those calculated according to equation in TIA-568-C.1.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- D. Remove and replace cabling where test results indicate that it does 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.

END OF SECTION 27 13 23

SECTION 27 15 13 - COMMUNICATIONS COPPER 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 SUMMARY

- A. Section Includes:
 - 1. Category 6a twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs and jacks.
 - 3. Cabling identification products.
 - 4. wireless access point mounts and enclosures.
 - 5. Grounding provisions for twisted pair cable.
- B. System shall be a complete operational 10 GIG, Category-6A local area network data cabling system, with a 10 GIG fiber optic backbone, excluding active devices. System shall be certified to this degree.

1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.
- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. Cabling administration Drawings and printouts.
 - 3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.
 - f. Typical telecommunications details.
 - g. Mechanical, electrical, and plumbing systems.
- C. Twisted pair cable testing plan.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.

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. Connecting Blocks: One of each type.
 - 2. Faceplates: One of each type.
 - 3. Jacks: Ten of each type.
 - 4. Patch-Panel Units: One of each type.
 - 5. Plugs: Ten of each type.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.
- C. A single installer shall be responsible for the procurement and installation of all wiring, cabling and accessories that make up the designed I.T. network described in these construction documents. This includes, but is not limited to: network racks, patch panels, rack-mounted power supplies, fiber optic cabling, and copper horizontal cabling.
 - 1. Separate contractors, sub-contractors, vendors, etc. shall not be permitted to install network wiring for their own IP-based systems, for example. This wiring shall only be permitted to be installed by the project's primary division 27 wiring installer.

1.9 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.

1.10 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.11 WARRANTY

- A. Provide a comprehensive cable/premise wiring device warranty from manufacturer of communication device system for no less than 25 years. This shall include a warranty on all parts and labor:
 - 1. The cabling/premise wiring device warranty and system performance guarantee program shall warrant the structured cabling system is free from defects in material and workmanship and will support any current or future Category-6A system applications ratified by IEEE, ANSI or ISO that is developed for an ANSI/TIA/EIA-568-D compliant structured cabling system for a 25-year period from date of registered installation. This warranty shall also include a warranty covering all components (work area outlets, horizontal cable, connecting hardware in the horizontal cross-connect, the equipment cord at the work area, and the patch cord in the horizontal cross-connect). All devices must be manufactured by warranty provider.
 - 2. Contractor must be a Certified Installer and accredited Certified Installer for the manufacturer of product being installed, as approved by Owner.

- B. Provide a one (1) year warranty on all other associated equipment not covered under warranty indicated above.
- C. The contractor shall provide a minimum one (1) year warranty for all parts and labor on each phase of construction, based upon the substantial completion date established for each phase of construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685.
- B. RoHS compliant.

2.3 CATEGORY 6a TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panduit.
- C. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Cable Rating: Plenum.
- G. Jacket: PVC.
 - 1. Data/Voice: Blue.
 - 2. Wireless Access Points: Orange.
 - 3. Security Cameras: Purple.

4. Access Control System: Black.
5. Intercom System: White.
6. Analog Voice: Grey.

H. Cable shall meet or exceed the following standards:

1. ANSI/TIA-568-C.2 and ISO/IEC 11801 component compliance.
2. IEEE 802.3af (PoE), IEEE 802.3at (PoE+), IEEE 802.3bt (4PPoE Type 3 and 4).
3. 10BASE-T through 10GBASE-T Ethernet at 100 meters and PoE+ and PoE++.
4. NEC Article 800 compliant.
5. Third party verified.
6. UL/c (UL) Listed, LP Listed for product safety in high heat/high power PoE+ and PoE++ applications.
7. HDASE-T Certified
8. RoHS/RoHS 2 Compliant.
9. REACH Compliant.
10. IEEE 802.11ac high bandwidth/high power wireless access point applications.
11. Tested to 100 watts.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
1. Comply with the performance requirements of Category 6a.
 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.
- D. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 2U 48 ports.
 - e. Shall utilize Panduit Mini-Com form factor.
 2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
- E. Patch Cords: Factory-made, four-pair cables in 12-inch lengths; terminated with an eight-position modular plug at each end.
1. Provide one patch cord for each terminated horizontal cable.

2. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
3. Patch cords shall have color-coded boots for circuit identification.
4. All patch cords shall be 24AWG, minimum.

F. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.

G. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Shall utilize Panduit Mini-Com form factor.
5. Color to match cable color.

H. Faceplate:

1. See faceplate details on drawings.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords - Shall utilize Panduit Mini-Com form factor.

I. Legend:

1. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 WIRELESS ACCESS POINT MOUNTS AND ENCLOSURES

- A. All new Wireless Access Points (WAPs) shall be provided by the Owner and shall be installed by the contractor. Asset tagging shall be performed by the Owner – the contractor shall sign for receipt of the WAP devices prior to installation.
- B. Contractor shall utilize grid mounting clips and cradle (furnished with WAP device) for lay-in ceiling installations – contractor shall provide additional rail kit as needed. Contractor shall install ID tag on ceiling grid and on label field on coverplate. For locations that are wall mounted, contractor shall furnish and install Oberon Series #1011-00-WH wall mount bracket with data jack enclosure. The final model number shall match Owner's WAP device being provided. Coordinate final WAP model with Owner prior to ordering unit.
- C. For new WAP locations in Gymnasiums, Multipurpose Rooms, high abuse areas, and Locker Rooms, furnish and install an Oberon #1024-C WAP enclosure with Owner provided WAP (after asset tagging) and mounting cradle inside of the enclosure. Mount enclosure to bottom of bar joists with through bolts, washers, lock washers and lock nuts. Install ID tag on enclosure and on label field on coverplate. Where these enclosures are shown to be wall mounted, mount devices horizontally and use Oberon -RAB right angle bracket to support these devices. Coordinate final WAP model with Owner prior to ordering unit.

- D. All locations shall be provided with boxes, coverplates, jacks, cabling, patch cords (both ends) and raceway as needed. All exposed conduits in gymnasiums, multipurpose rooms, pools, and other areas shall be painted out to match area. All new WAP devices must be mounted horizontally and parallel with the floor.
- E. Contractor shall patch WAP into adjacent network drop – patch into port E0.
- F. All new cabling shall be tested and certified.

2.6 IP PHONE SYSTEM INFRASTRUCTURE

- 1. The complete IP phone system shall be furnished, installed and programmed by the owner.
- 2. Contractor shall furnish (100) six ft. Cat6A patch cables for patching-in of IP Phones into wall jack.

2.7 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

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 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.
- 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. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 27 1100 "Communications Equipment Room Fittings."
- B. Comply with Section 27 0528 "Pathways for Communications Systems."

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. Examine pathway elements intended for cables.
 - 1. Verify proposed routes of pathways. Check raceways, cable trays, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with EMI clearance requirements. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 2. Prepare wall penetrations and verify that penetrations of rated fire walls are made using products labeled for type of wall penetrated.
 - 3. Identify plan to support cables and raceways in suspended ceilings. Verify weight of individual types and sizes of cables. Verify that load capacity of cable support structures is adequate for each pathway.
 - 4. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Verify that surfaces are ready and clean to receive work.
- D. Verify that quantity and sizes of boxes/conduit are acceptable for installation of jacks and cabling.
- E. Make contractor and architect aware of any condition on-site that may interfere or cause damage to installation of system.
- F. Beginning installation means installer accepts existing conditions.
- G. Installer shall coordinate work with all tradesmen.
- H. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.
- I. Comply with TIA/EIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- J. Comply with requirements in Division 26 Sections for installation of conduits and wireways.
- K. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. MUTOA shall not be used as a cross-connect point.
 - 7. Consolidation points may be used only for making a direct connection to equipment outlets:

- a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.
8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual , Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 11. 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.
 12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 13. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
 14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- L. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- M. Group connecting hardware for cables into separate logical fields.
- 3.4 FIRESTOPPING
- A. Comply with requirements in Section 07 8413 "Penetration Firestopping."
 - B. Comply with TIA-569-D, Annex A, "Firestopping."
 - C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."
- 3.5 GROUNDING
- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
 - B. Comply with TIA-607-B and NECA/BICSI-607.

- C. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- B. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- C. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes 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 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-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair 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-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.

- D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- F. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

END OF SECTION 27 15 13

SECTION 28 13 00 – ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

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 DOCUMENTS

- A. Drawings and general provisions of the Contract, including CDB Standard Documents for Construction, apply to this Section.

1.3 SUMMARY

A. Section Includes:

- 1. Security access operating system and application software.
- 2. Security access controllers connected to high-speed electronic-data transmission network.

B. Related Requirements:

- 1. Section 28 1500 "Access Control System Hardware Devices" for access control system hardware, such as keypads, card readers, and biometric identity devices.

1.4 DEFINITIONS

- A. Credential: Data assigned to an entity and used to identify that entity.
- B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- C. 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.
- D. Location: A Location on the network having a workstation-to-controller communications link, with additional controllers at the Location connected to the workstation-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.
- E. Workstation: Personal computer. Applies to the central station, workstations, and file servers.
- F. RAS: Remote access services.
- G. RF: Radio frequency.

- H. ROM: Read-only memory. ROM data are maintained through losses of power.
- I. TCP/IP: Transport control protocol/Internet protocol.
- J. 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.
- K. WMP: Windows media player.
- L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.5 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. Diagrams for cable management system.
 - 2. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - 3. Cable Administration Drawings: As specified in "Identification" Article.
 - 4. Battery and charger calculations for central station, workstations, and controllers.
- C. Product Schedules.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.7 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 01 7823 "Operation and Maintenance Data," include the following:
 - 1. Workstation operating system documentation.

2. Workstation installation and operating documentation, manuals, and software for the workstation and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each workstation.
3. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files.
4. System installation and setup guides with data forms to plan and record options and setup decisions.

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. 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.
 2. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.
- B. Source Limitations: Obtain controllers, Identifier readers, and all software through one source from single manufacturer.

1.10 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, 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.

1.11 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:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F 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 temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Outdoor Environment: NEMA 250, NEMA 250, Type 3R 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 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.

PART 2 - PRODUCTS

2.1 ACCESS CONTROL SOFTWARE

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

1. EcoStruxure Security Expert by Schneider Electric.

2.2 DESCRIPTION

- A. Security Access System: Workstation-based central station, one or more networked workstation-based workstations, and field-installed controllers, connected by a high-speed electronic-data transmission network.
1. The access control integrator shall provide to the owner a graphical user interface for monitoring and control of the security access system. This graphical interface shall be available to any workstation PC on the owner's network furnished with the appropriate software or through a web-based application. The graphical interface shall be integrated into the owner's building automation system graphical interface. Permission levels shall be established allowing users to monitor and control the security access system, but not necessarily the temperature control system.
 2. The security access system shall be capable of alerting the owner of unauthorized access or door-ajar instances. This alert shall be illustrated on the graphical user interface and through email notifications to up to four administrators. Graphical user interface shall provide user input parameter on time delay before door-ajar alert is annunciated on GUI. GUI operator shall have opportunity to silence alert prior to email notifications.
 3. The security access system shall be modular, networked, and capable of handling infrastructures with multiple remote sites, access control, intrusion detection, alarm monitoring, video imaging, photo identification, with capabilities to provide integration with 3rd party applications as applicable including but not limited to digital video management systems, building automation system, key management systems, elevator management systems and wireless lock systems. The system shall allow for easy expansion or modification of inputs, outputs, and remote-control stations.
 4. Integrated Solution: The system shall support integrated Access Control, Intrusion and IP intercom functions natively. Separate system controllers for Access Control and Intrusion Alarms shall not be acceptable. Separate Security Management Server and VoIP intercom server shall not be acceptable.
 5. System shall make physical connection to owner's IP phone system and shall allow for select door unlocking of up to our doors from up to four IP phones.

6. Systems that utilize serial-based proximity readers with Ethernet-serial converters shall NOT be approved.
 7. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer's system.
- B. System Software: Based on 64-bit, Microsoft Windows, central-station, workstation operating system, server operating system, and application software. Software shall have the following capabilities:
1. Multiuser and multitasking to allow for independent activities and monitoring to occur simultaneously at different workstations.
 2. Graphical user interface to show pull-down menus and a menu-tree format that complies with interface guidelines of the operating system.
 3. System license for the entire system including capability for future additions that are within the indicated system size limits specified in this Section.
 4. Open-architecture system that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
 5. Password-protected operator login and access.
 6. Open-database-connectivity compliant.
- C. Network(s) connecting workstations and controllers shall consist of one or more of the following:
1. Local area, IEEE 802.3 Fast Ethernet Gigabit-Ethernet, star topology network based on TCP/IP.

2.3 OPERATION

- A. Security access system shall use a single database for access-control and credential-creation functions.
- B. Distributed Processing: A fully distributed processing system.
1. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
 2. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the central station.
- C. System Network Requirements:
1. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
 2. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
 3. System shall automatically annunciate communication failures to the operator and shall identify the communications link that has experienced a partial or total failure.
- D. Central station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central station shall control system networks to interconnect all system components, including workstations and field-installed controllers. The system control at the central computer location shall be under a single server software program control, shall provide full integration of all components, and shall

be alterable at any time, depending upon the facility requirements. Reconfiguration shall be accomplished online through system programming, without hardware changes.

- E. Field equipment shall include controllers, sensors, and controls.
 - 1. Controllers shall serve as an interface between the central station and sensors and controls.
 - 2. Data exchange between the central station and the controllers shall include down-line transmission of commands, software, and databases to controllers.
 - 3. The up-line data exchange from the controller to the central station shall include status data such as intrusion alarms, status reports, and entry-control records.
 - 4. Controllers are classified as alarm-annunciation or entry-control type.
- F. Error Detection:
 - 1. Use a cyclic code method to detect single- and double-bit errors, burst errors of eight bits or fewer, and at least 99 percent of all other multibit and burst errors between controllers and the central station.
- G. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.
- H. Door Hardware Interface:
 - 1. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

2.4 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. Comply with NFPA 70, "National Electrical Code."

2.5 APPLICATION SOFTWARE

- A. System Software: Based on 32-bit, Microsoft Windows central-station and workstation operating system and application software.
 - 1. Multiuser multitasking shall allow independent activities and monitoring to occur simultaneously at different workstations.
 - 2. Graphical user interface shall show pull-down menus and a menu-tree format.
 - 3. Capability for future additions within the indicated system size limits.
 - 4. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
 - 5. Password-protected operator login and access.
- B. Application Software: Interface between the alarm annunciation and entry-control controllers to monitor sensors, operate displays, report alarms, generate reports, and help train system operators.

1. Reside at the central station, workstations, and controllers as required to perform specified functions.
2. Operate and manage peripheral devices.
3. Manage files for disk I/O, including creating, deleting, and copying files; and automatically maintain a directory of all files, including size and location of each sequential and random-ordered record.
4. Import custom icons into graphics to represent alarms and I/O devices.
5. Globally link I/O so that any I/O can link to any other I/O within the same Location without requiring interaction with the host workstation. This operation shall be at the controller.
6. Globally code I/O links so that any access-granted event can link to any I/O with the same Location without requiring interaction with the host workstation. This operation shall be at the controller.
7. Messages from workstation to controllers and controllers to controllers shall be on a polled network that utilizes check summing and acknowledgment of each message. Communication shall be automatically verified, buffered, and retransmitted if message is not acknowledged.
8. Selectable poll frequency and message time-out settings shall handle bandwidth and latency issues for TCP/IP, RF, and other workstation-to-controller communications methods by changing the polling frequency and the amount of time the system waits for a response.
9. Automatic and encrypted backups for database and history backups shall be automatically stored at the central-control workstation and encrypted with a nine-character alphanumeric password that must be used to restore or read data contained in backup.
10. Operator audit trail for recording and reporting all changes made to database and system software.
11. Support network protocol and topology, TCP/IP, Novel Netware, Digital Pathworks, Banyan Vines, LAN/WAN, and RAS.

C. Workstation Software:

1. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each Location.
2. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is unacknowledged (not handled by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

D. Controller Software:

1. Controllers shall operate as autonomous, intelligent processing units.
 - a. Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
 - b. Controllers shall be part of a fully distributed processing-control network.
 - c. The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.
2. The following functions shall be fully implemented and operational within each controller:
 - a. Monitoring inputs.
 - b. Controlling outputs.
 - c. Automatically reporting alarms.
 - d. Reporting of sensor and output status.
 - e. Maintaining real time.
 - f. Executing controller resident programs.
 - g. Diagnosing.

- h. Downloading and uploading data to and from the central station.
3. Controller Operations at a Location:
- a. Up to 64 controllers connected to TIA 485-A communications loop. Globally operating I/O linking and anti-passback functions between controllers within the same Location without central-station or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the central station or workstations are off-line.
 - b. In the event of communication failure between the central station and a Location, there shall be no degradation in operations at the controllers at that Location. Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
 - c. Buffered events shall be handled in a first-in-first-out mode of operation.
4. Individual Controller Operation:
- a. Controllers shall transmit alarms, status changes, and other data to the central station when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the central station, shall be stored for later transmission. Storage capacity for the latest 1024 events shall be provided at each controller.
 - b. Card-reader ports of a controller shall be custom configurable for at least 120 different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different controllers or within the same controller.
 - c. Controllers shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
 - d. Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
 - e. Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.
 - f. On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
 - g. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.
 - h. After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the central station.
5. Communications Monitoring:
- a. System shall monitor and report status communications loop of each Location.
 - b. Communication status window shall display which controllers are currently communicating, a total count of missed polls since midnight, and which controller last missed a poll.

6. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central station at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.
- E. Workstation-to-Controller Communications:
1. Central-station or workstation communications shall use the following:
 - a. Direct connection using serial ports of the workstation.
 - b. TCP/IP LAN interface cards.
 - c. Dial-up or cable modems for connections to Locations.
 2. Each serial port used for communications shall be individually configurable for "direct communications," "modem communications incoming and outgoing," or "modem communications incoming only," or as an ASCII output port. Serial ports shall have adjustable data transmission rates and shall be selectable under program control.
 3. Use multiport communications board if more than two serial ports are needed.
 - a. Use a 4-, 8-, or 16-serial port configuration that is expandable to 32- or 64-serial ports.
 - b. Connect the first board to an internal PCI bus adapter card.
 4. Direct serial, TCP/IP, and dial-up, cable, or satellite communications shall be alike in the monitoring or control of the system except for the connection that must first be made to a dial-up or voice-over IP Location.
 5. TCP/IP network interface card (NIV) shall have an option to set the poll-frequency and message-response time-out settings.
 6. Workstation-to-controller and controller-to-controller communications (direct, dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications in this subparagraph shall be verified and buffered, and retransmitted if not acknowledged.
- F. Controller-to-Controller Communications:
1. TIA 485-A, four-wire, point-to-point, regenerative (repeater) communications network methodology.
 2. TIA 485-A communications signal shall be regenerated at each controller.
- G. Database Downloads:
1. All data transmissions from workstations to a Location, and between controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
 2. If a controller is reset for any reason, it shall automatically request and receive a database download from the workstation. The download shall restore data stored at the controller to their normal working state and shall take place with no operator intervention.
- H. Operator Interface:
1. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.

2. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
 3. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
 4. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.
 5. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.
 6. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:
 - a. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
 - b. Maps to provide real-time display animation and allow for control of points assigned to them.
 - c. System to allow inputs, outputs, and override groups to be placed on different maps.
 - d. Software to allow changing the order or priority in which maps will be displayed.
 7. Override Groups Containing I/Os:
 - a. System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.
 - b. Icon shall change automatically to show the live summary status of points in that group.
 - c. Override group icon shall provide a method to manually control or set to time-zone points in the group.
 - d. Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.
 8. Schedule Overrides of I/Os and Override Groups:
 - a. To accommodate temporary schedule changes that do not fall within the holiday parameters, the operator shall have the ability to override schedules individually for each input, output, or override group.
 - b. Each schedule shall be composed of a minimum of two dates with separate times for each date.
 - c. The first time and date shall be assigned the override state that the point shall advance to when the time and date become current.
 - d. The second time and date shall be assigned the state that the point shall return to when the time and date become current.
 9. Copy command in database shall allow for like data to be copied and then edited for specific requirements, to reduce redundant data entry.
- I. Operator Access Control:
1. Control operator access to system controls through three password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.

2. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.
3. A minimum of 1024 unique user accounts shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.
4. The password shall not be displayed or printed.
5. Each password shall be definable and assignable for the following:
 - a. Selected commands to be usable.
 - b. Access to system software.
 - c. Access to application software.
 - d. Individual zones that are to be accessed.
 - e. Access to database.

J. Operator Commands:

1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
2. Command inputs shall be acknowledged and processing shall start in not less than one second(s).
3. Tasks that are executed by operator's commands shall include the following:
 - a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
 - b. Place Zone in Access: Used to remotely disable intrusion-alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
 - c. Place Zone in Secure: Used to remotely activate intrusion-alarm circuits emanating from a specific zone.
 - d. System Test: Allows the operator to initiate a system-wide operational test.
 - e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
 - f. Print reports.
 - g. Change Operator: Used for changing operators.
 - h. Security Lighting Controls: Allows the operator to remotely turn on or turn off security lights.
 - i. Display Graphics: Used to show any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
 - j. Run system tests.
 - k. Generate and format reports.
 - l. Request help with the system operation.
 - 1) Include in main menus.
 - 2) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.
 - 3) Provide navigation to specific topic from within the first help window.
 - 4) Help shall be accessible outside the application program.
 - m. Entry-Control Commands:
 - 1) Lock (secure) or unlock (open) each controlled entry and exit up to four times a day through time-zone programming.

- 2) Arm or disarm each monitored input up to four times a day through time-zone programming.
 - 3) Enable or disable readers or keypads up to two times a day through time-zone programming.
 - 4) Enable or disable cards or codes up to four times a day per entry point through access-level programming.
4. Command Input Errors: Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command cannot be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:
- a. Command entered is incorrect or incomplete.
 - b. Operator is restricted from using that command.
 - c. Command addresses a point that is disabled or out of service.
 - d. Command addresses a point that does not exist.
 - e. Command is outside the system's capacity.
- K. Alarms:
1. System Setup:
 - a. Assign manual and automatic responses to incoming-point status change or alarms.
 - b. Automatically respond to input with a link to other inputs, outputs, or operator-response plans; unique sound with use of WAV files; and maps or images that graphically represent the point location.
 - c. Sixty-character message field for each alarm.
 - d. Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages.
 - e. Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.
 - f. Allow 25 secondary messages with a field of four lines of 60 characters each.
 - g. Store the most recent 1000 alarms for recall by the operator using the report generator.
 2. Software Tamper:
 - a. Annunciate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
 - b. Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond the authorization level.
 - c. Maintain a transcript file of the last 5000 commands entered at each central station to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.
 - d. Allow only acknowledgment of software tamper alarms.
 3. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.

4. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
 5. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
- L. Alarm Monitoring: Monitor sensors, controllers, and DTS circuits and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.
1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
 2. Maps shall automatically display the alarm condition for each input assigned to that map if that option is selected for that input location.
 3. Alarms initiate a status of "pending" and require the following two handling steps by operators:
 - a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
 - b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.
 4. Each workstation shall display the total pending alarms and total unresolved alarms.
 5. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
 6. Alarms shall be displayed and managed from a minimum of four different windows.
 - a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
 - b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
 - c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
 - d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.
 7. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
 8. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
 9. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
 10. Identical alarms from the same alarm point shall be acknowledged at the same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
 11. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and controllers.
 12. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.

- M. System test software enables operators to initiate a test of the entire system or of a particular portion of the system.
1. Test Report: The results of each test shall be stored for future display or printout. The report shall document the operational status of system components.
- N. Report-Generator Software: Include commands to generate reports for displaying, printing, and storing on disk and tape. Reports shall be stored by type, date, and time. Report printing shall be the lowest-priority activity. Report-generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.
1. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm (such as door alarm, intrusion alarm, tamper alarm, etc.), the type of sensor, the location, the time, and the action taken.
 2. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
 3. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future printing.
 4. Automatic History Reports: Named, saved, and scheduled for automatic generation.
 5. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
 6. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
 7. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
 8. Who Is "In" (Muster) Report:
 - a. Emergency Muster Report: One-click operation on toolbar launches report.
 - b. Cardholder Report. Contain a count of persons who are "In" at a selected Location and a detailed listing of name, date, and time of last use, sorted by the last reader used or by the group assignment.
 9. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that data are available on-site at all times.
 10. Activity and Alarm On-Line Printing: Activity printers for use at workstations; prints all events, or alarms only.
 11. History Reports: Custom reports that allow the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.
 - a. Initially store history on the hard disk of the host workstation.
 - b. Permit viewing of the history on workstations or print history to any system printer.
 - c. The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.
 - d. Each report shall depict the date, time, event type, event description, and device; or I/O name, cardholder group assignment, and cardholder name or code number.
 - e. Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.

- f. Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.
 12. Reports shall have the following four options:
 - a. View on screen.
 - b. Print to system printer. Include automatic print spooling and "Print To" options if more than one printer is connected to the system.
 - c. "Save to File" with full path statement.
 - d. System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.
 13. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:
 - a. Active, inactive, or future activate or deactivate.
 - b. Code number, name, or imprinted card number.
 - c. Group, Location access levels.
 - d. Start and stop code range.
 - e. Codes that have not been used since a selectable number of days.
 - f. In, out, or either status.
 - g. Codes with trace designation.
 14. The reports of system database shall allow options so that every data field may be printed.
 15. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows.
- O. Anti-Passback:
1. System shall have local anti-passback features. System shall support hard and soft anti-passback.
 2. Hard Anti-Passback: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes through a reader of opposite designation.
 3. Soft Anti-Passback: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting the credential holder and the door involved in the violation. A separate report may be run on this event.
 4. Timed Anti-Passback: A controller capability that prevents an access code from being used twice at the same device (door) within a user-defined amount of time.
 5. The anti-passback schemes shall be definable for each individual door.
 6. The Master Access Level shall override anti-passback.
 7. System shall have the ability to forgive (or reset) an individual credential holder or the entire credential-holder population anti-passback status to a neutral status.
- P. Visitor Assignment:
1. Provide for and allow an operator to be restricted to only working with visitors. The visitor badging subsystem shall assign credentials and enroll visitors. Allow only those access levels that have been designated as approved for visitors.

2. Provide an automated log of visitor name, time and doors accessed, and name of person contacted.
3. Allow a visitor designation to be assigned to a credential holder.
4. Security access system shall be able to restrict the access levels that may be assigned to credentials issued to visitors.
5. Allow operator to recall visitors' credential-holder file once a visitor is enrolled in the system.
6. The operator may designate any reader as one that deactivates the credential after use at that reader. The history log shall show the return of the credential.
7. System shall have the ability to use the visitor designation in searches and reports. Reports shall be able to print all or any visitor activity.

Q. Time and Attendance:

1. Time and attendance reporting shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length designated in the report.
2. Shall be provided to match IN and OUT reads and display cumulative time in for each day and cumulative time in for length designated in the report.
3. System software setup shall allow designation of selected access-control readers as time and attendance hardware to gather the clock-in and clock-out times of the users at these readers.
 - a. Reports shall show in and out times for each day, total time in for each day, and a total time in for period specified by the user.
 - b. Allow the operator to view and print the reports, or save the reports to a file.
 - c. Alphabetically sort reports on the person's last name, by Location or location group. Include all credential holders or optionally select individual credential holders for the report.

R. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.

1. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
2. The program shall provide means to disable the enrollment station when it is unattended, to prevent unauthorized use.
3. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity-verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity-verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
4. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:
 - a. MASK: Determines a specific format with which data must comply.
 - b. REQUIRED: Operator is required to enter data into field before saving.
 - c. UNIQUE: Data entered must be unique.
 - d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
 - e. NAME ID: Data entered will be considered a unique ID for the cardholder.

5. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
6. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
7. Batch card printing.
8. Default card data can be programmed to speed data entry for sites where most card data are similar.
9. Enhanced ASCII File Import Utility: Allows the importing of cardholder data and images.
10. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

2.6 SYSTEM DATABASE

- A. Database and database management software shall define and modify each point in database using operator commands. Definition shall include parameters and constraints associated with each system device.
- B. Database Operations:
 1. System data management shall be in a hierarchical menu-tree format, with navigation through expandable menu branches and manipulated with use of menus and icons in a main menu and system toolbar.
 2. Navigational Aids:
 - a. Toolbar icons for add, delete, copy, print, capture image, activate, deactivate, and muster report.
 - b. Point and click feature to facilitate data manipulation.
 - c. Next and previous command buttons visible when editing database fields to facilitate navigation from one record to the next.
 - d. Copy command and copy tool in the toolbar to copy data from one record to create a new similar record.
 3. Data entry shall be automatically checked for duplicate and illegal data and shall be verified for valid format.
 4. System shall generate a memo or note field for each item that is stored in database, allowing the storing of information about any defining characteristics of the item. Memo field is used for noting the purpose for which the item was entered, reasons for changes that were made, and the like.
- C. File Management:
 1. File management shall include database backup and restoration system, allowing selection of storage media.
 2. Operations shall be both manual and automatic modes. The number of automatic sequential backups before the oldest backup will be overwritten; FIFO mode shall be operator selectable.
 3. Backup program shall provide manual operation from any workstation on the LAN and shall operate while system remains operational.
- D. Operator Passwords:

1. Support up to 32,000 individual system operators, each with a unique password.
 2. One to eight alphanumeric characters.
 3. Allow passwords to be case sensitive.
 4. Passwords shall not be displayed when entered.
 5. Passwords shall have unique and customizable password profile, and allow several operators to share a password profile. Include the following features in the password profile:
 - a. Predetermine the highest-level password profile for access to all functions and areas of program.
 - b. Allow or disallow operator access to any program operation, including the functions of View, Add, Edit, and Delete.
 - c. Restrict doors to which an operator can assign access.
 6. Operators shall use a user name and password to log on to system. This user name and password shall be used to access database areas and programs as determined by the associated profile.
 7. Make provision to allow the operator to log off without fully exiting program. User may be logged off but program will remain running while displaying the login window for the next operator.
- E. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).
1. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-passback status, and number of uses last.
 2. Use data-entry windows to view, edit, and issue access levels. Access-authorization entry-management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
 3. Allow assignment of multiple cards/codes to a cardholder.
 4. Allow assignment of up to four access levels for each Location to a cardholder. Each access level may contain any combination of doors.
 5. Each door may be assigned four time zones.
 6. Access codes may be up to 11 digits in length.
 7. Visitor Access: Issue a visitor badge for data tracking or photo ID purposes without assigning that person a card or code.
 8. Allow each cardholder to be given either an unlimited number of uses or a number from one to 9999 that regulates the number of times the card can be used before it is automatically deactivated.
 9. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.
- F. Security Access Integration:
1. Photo ID badging and photo verification shall use the same database as the security access and may query data from cardholder, group, and other personal information to build a custom ID badge.
 2. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
 3. System shall allow sorting of cardholders together by group or other characteristic for a fast and efficient method of reporting on, and enabling or disabling, cards or codes.
- G. Key control and tracking shall be an integrated function of cardholder data.

1. Provide the ability to store information about which conventional metal keys are issued and to whom, along with key construction information.
2. Reports shall be designed to list everyone who possesses a specified key.

H. Operator Comments:

1. With the press of one appropriate button on the toolbar, the user shall be permitted to enter operator comments into the history at any time.
2. Automatic prompting of operator comment shall occur before the resolution of each alarm.
3. Operator comments shall be recorded by time, date, and operator number.
4. Comments shall be sorted and viewed through reports and history.
5. The operator may enter comments in two ways; either or both may be used:
 - a. Manually entered through keyboard data entry (typed), up to 65,000 characters per each alarm.
 - b. Predefined and stored in database for retrieval on request.
6. System shall have a minimum of 999 predefined operator comments with up to 30 characters per comment.

I. Group:

1. Group names may be used to sort cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, division, or any other designation of a group to which the person belongs.
2. System software shall have the capacity to assign one of 32,000 group names to an access authorization.
3. Make provision in software to deactivate and reactivate all access authorizations assigned to a particular group.
4. Allow sorting of history reports and code list printouts by group name.

J. Time Zones:

1. Each zone consists of a start and stop time for seven days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
2. Up to four time zones may be assigned to inputs and outputs to allow up to four arm or disarm periods per day or four lock or unlock periods per day; up to three holiday override schedules may be assigned to a time zone.
3. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.

K. Holidays:

1. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date matches the current date of the time zone, the holiday schedule replaces the time-zone schedule for that 24-hour period.
2. System shall have the capacity for 32,000 holidays.

3. Three separate holiday schedules may be applied to a time zone.
4. Holidays have an option to be designated as occurring on the designated date each year. These holidays remain in the system and will not be purged.
5. Holidays not designated to occur each year shall be automatically purged from the database after the date expires.

L. Access Levels:

1. System shall allow for the creation of up to 32,000 access levels.
2. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
3. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
4. System shall be able to create multiple door and time-zone combinations under the same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same controller.

M. User-Defined Fields:

1. System shall provide a minimum of 99 user-defined fields, each with up to 50 characters, for specific information about each credential holder.
2. System shall accommodate a title for each field; field length shall be 20 characters.
3. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.
4. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
5. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
6. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YYYY date format. The credential of the holder will be deactivated on that date.
7. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include a search for a character string.
8. System shall have the ability to print cardholders based on and organized by the user-defined fields.

2.7 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.

2.8 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.
- B. Subject to compliance with requirements in this article, manufacturers may use multipurpose controllers.
- C. Alarm Annunciation Controller:
 - 1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network.
 - 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 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 10 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 software.
 - 2. Auxiliary Equipment Power: A GFI service outlet inside the controller enclosure.
- D. 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.
 - 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.

2.9 FIELD-PROCESSING SOFTWARE

A. Operating System:

1. Local processors shall contain an operating system that controls and schedules that local processor's activities in real time.
2. Local processor shall maintain a point database in its memory that includes parameters, constraints, and the latest value or status of all points connected to that local processor.
3. Execution of local processor application programs shall utilize the data in memory resident files.
4. Operating system shall include a real-time clock function that maintains the seconds, minutes, hours, date, and month, including day of the week.
5. Local processor real-time clock shall be automatically synchronized with the central station at least once per day to plus or minus 10 seconds (the time synchronization shall be accomplished automatically, without operator action and without requiring system shutdown).

B. Startup Software:

1. Causes automatic commencement of operation without human intervention, including startup of all connected I/O functions.
2. Local processor restart program based on detection of power failure at the local processor shall be included in the local processor software.
3. Initiates operation of self-test diagnostic routines.
4. Upon failure of the local processor, if the database and application software are no longer resident, the local processor shall not restart and systems shall remain in the failure mode indicated until the necessary repairs are made.
5. If the database and application programs are resident, the local processor shall immediately resume operation.

C. Operating Mode:

1. Local processors shall control and monitor inputs and outputs as specified, independent of communications with the central station or designated workstations.
2. Alarms, status changes, and other data shall be transmitted to the central station or designated workstations when communications circuits are operable.
3. If communications are not available, each local processor shall function in a stand-alone mode and operational data, including the status and alarm data normally transmitted to the central station or designated workstations, shall be stored for later transmission to the central station or designated workstations.
4. Storage for the latest 4000 events shall be provided at local processors, as a minimum.
5. Local processors shall accept software downloaded from the central station.
6. Panel shall support flash ROM technology to accomplish firmware downloads from a central location.

D. Failure Mode: Upon failure for any reason, each local processor shall perform an orderly shutdown and force all local processor outputs to a predetermined (failure-mode) state, consistent with the failure modes shown and the associated control device.

E. Functions:

1. Monitoring of inputs.
2. Control of outputs.
3. Reporting of alarms automatically to the central station.
4. Reporting of sensor and output status to central station upon request.
5. Maintenance of real time, automatically updated by the central station at least once a day.
6. Communication with the central station.
7. Execution of local processor resident programs.
8. Diagnostics.
9. Download and upload data to and from the central station.

2.10 FIELD-PROCESSING HARDWARE

A. Alarm Annunciation Local Processor:

1. Respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.

2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
3. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
4. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
5. Local processor shall report line supervision alarms to the central station.
6. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 milliseconds.
7. Alarm condition shall be transmitted to the central computer during the next interrogation cycle.
8. Local processor outputs shall reflect the state of commands issued by the central station.
9. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
10. Local processor shall have at least four command outputs.
11. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.

B. Processor Power Supply:

1. Local processor and sensors shall be powered from an uninterruptible power source.
2. Uninterruptible power source shall provide eight hours of battery back-up power in the event of primary power failure and shall automatically fully recharge the batteries within 12 hours after primary power is restored.
3. If the facility is without an emergency generator, the uninterruptible power source shall provide 24 hours of battery backup power.
4. There shall be no equipment malfunctions or perturbations or loss of data during the switch from primary to battery power and vice versa.
5. Batteries shall be sealed, non-outgassing type.
6. Power supply shall be equipped with an indicator for ac input power and an indicator for dc output power.
7. Loss of primary power shall be reported to the central station as an alarm.

C. Auxiliary Equipment Power: A GFI service outlet shall be furnished inside the local processor's enclosure.

D. Entry-Control Local Processor:

1. Entry-control local processor shall respond to interrogations from the field device network, recognize and store alarm status inputs until they are transmitted to the central station, and change outputs based on commands received from the central station.
2. Local processor shall also automatically restore communication within 10 seconds after an interruption with the field device network and provide dc line supervision on each of its alarm inputs.
3. Entry-control local processor shall provide local entry-control functions including communicating with field devices such as card readers, keypads, biometric personnel identity-verification devices, door strikes, magnetic latches, gate and door operators, and exit push buttons.
4. Processor shall also accept data from entry-control field devices as well as database downloads and updates from the central station that include enrollment and privilege information.
5. Processor shall send indications of successful or failed attempts to use entry-control field devices and shall make comparisons of presented information with stored identification information.

6. Processor shall grant or deny entry by sending control signals to portal-control devices and mask intrusion-alarm annunciation from sensors stimulated by authorized entries.
7. Entry-control local processor shall use inputs from entry-control devices to change modes between access and secure.
8. Local processor shall maintain a date-time- and location-stamped record of each transaction and transmit transaction records to the central station.
9. Processor shall operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the local processor and the central station.
10. Processor shall store a minimum of 4000 transactions during periods of communication loss between the local processor and the central station for subsequent upload to the central station upon restoration of communication.
11. Local processor inputs shall monitor dry contacts for changes of state that reflect alarm conditions.
12. Local processor shall have at least eight alarm inputs which allow wiring contacts as normally open or normally closed for alarm conditions; and shall also provide line supervision for each input by monitoring each input for abnormal open, grounded, or shorted conditions using dc current change measurements.
13. Local processor shall report line supervision alarms to the central station.
14. Alarms shall be reported for any condition that remains abnormal at an input for longer than 500 ms.
15. Alarm condition shall be transmitted to the central station during the next interrogation cycle.
16. Entry-control local processor shall include the necessary software drivers to communicate with entry-control field devices. Information generated by the entry-control field devices shall be accepted by the local processor and automatically processed to determine valid identification of the individual present at the portal.
17. Upon authentication of the credentials or information presented, the local processor shall automatically check privileges of the identified individual, allowing only those actions granted as privileges.
18. Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control. The local processor shall maintain a date-time- and location-stamped record of each transaction.
19. 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.
20. Local processor outputs shall reflect the state of commands issued by the central station.
21. Outputs shall be a form C contact and shall include normally open and normally closed contacts.
22. Local processor shall have at least four addressable outputs.
23. The entry-control local processor shall also provide control outputs to portal-control devices.
24. Local processor shall be able to communicate with the central station via RS-485 or TCP/IP as a minimum.
25. The system manufacturer shall provide strategies for downloading database information for panel configurations and cardholder data to minimize the required download time when using IP connectivity.

2.11 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 workstations, 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 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules 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.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.3 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 26 0553 "Identification for Electrical Systems" and with TIA 606-B.

- B. 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.
- C. At completion, cable and asset management software shall reflect as-built conditions.

3.4 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.

3.5 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.

3.6 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.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. 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 28 13 00

SECTION 28 15 00 – ACCESS CONTROL HARDWARE DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Card readers, credential cards, and keypads
- 2. Biometric identity-verification equipment
- 3. Cables
- 4. Transformers

B. Related Requirements:

- 1. Section 28 130 0 "Access Control System Software and Database Management" for control and monitoring applications, workstations, and interfaces.

1.3 DEFINITIONS

- A. Credential: Data assigned to an entity and used to identify that entity.
- B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.
- C. 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.
- D. 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.
- E. PC: Personal computer. Applies to the central station, workstations, and file servers.
- F. RAS: Remote access services.
- G. RF: Radio frequency.
- H. ROM: Read-only memory. ROM data are maintained through losses of power.
- I. TCP/IP: Transport control protocol/Internet protocol.

- J. 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.
- K. WMP: Windows media player.
- L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- M. 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. Diagrams for cable management system.
 - 2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
 - 3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
 - a. Workstation outlets, jacks, and jack assemblies.
 - b. Patch cords.
 - c. Patch panels.
 - 4. Cable Administration Drawings: As specified in "Identification" Article.
 - 5. Battery and charger calculations for central station, workstations, and controllers.
- C. Product Schedules.

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 01 7823 "Operation and Maintenance Data," include the following:
 - 1. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files of the hard-copy submittal.
 - 2. 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. Credential fobs: 100.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.
- B. 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.
- C. 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.
- D. 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 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 temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
 - 3. Outdoor Environment: NEMA 250, NEMA 250, Type 3R 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 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 and snow cover up to 24 inches thick.

PART 2 - PRODUCTS

2.1 OPERATION

- A. Security access system hardware shall use a single database for access-control and credential-creation functions.

2.2 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. Comply with NFPA 70, "National Electrical Code."

2.3 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. HID.
 - 2. Bosch Security Systems, Inc.
 - 3. Hirsch Electronics Corporation.
 - 4. Honeywell International Inc.
- B. 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 from the reader.
 - 4. Proximity readers shall utilize Multi Card Technology. The range of card readers shall be available with either 125kHz proximity or 13.56MHz smart card capability or as a multi technology reader that combines both capabilities in a single unit
- C. Communication Protocol: Compatible with local processor.
- D. Touch-Plate and Contactless Card Reader: The reader shall have "flash" download capability to accommodate card format changes. The card reader shall have capability of transmitting data to security control panel and shall comply with ISO/IEC 7816.
- E. Credential Card Modification: Entry-control cards shall be able to be modified by lamination direct print process during the enrollment process without reduction of readability. The design of the credential cards shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the badge holder used at the site.

2.4 CABLES

- A. General Cable Requirements: Comply with requirements in Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables" and as recommended by system manufacturer for integration requirement.
- B. PVC-Jacketed, TIA 232-F.
 - 1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Polypropylene insulation.
 - 3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
 - 4. PVC jacket.
 - 5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with UL 1581.
- C. PVC-Jacketed, TIA 485-A Cables:
 - 1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. NFPA 70 Type: Type CMG.
 - 6. Flame Resistance: Comply with UL 1581.
- D. Multiconductor, PVC, Reader and Wiegand Keypad Cables:
 - 1. No. 18 AWG, paired and twisted multiple conductors, stranded (7x26) tinned copper conductors, semirigid PVC insulation, overall aluminum-foil shield with 100 percent shield coverage.
 - 2. NFPA 70, Type CMG.
 - 3. Flame Resistance: UL 1581 vertical tray.
 - 4. For TIA 232-F applications.
- E. LAN Cabling:
 - 1. Comply with requirements in Section 27 1513 "Communications Copper Horizontal Cabling."

2.5 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 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
- D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules 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 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring Method: Install wiring in raceway unless concealed above lay-in ceiling and supported by J-hooks no more than five feet on center.
- D. Install LAN cables using techniques, practices, and methods that are consistent with Category 5e rating of components and optical fiber rating of components, and that ensure Category 6 and optical fiber performance of completed and linked signal paths, end to end.
- E. 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.
- F. 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-D, "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. between terminations.

- D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. between terminations.
- E. Card Readers and Keypads:
 - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - 2. Install minimum No. 18 AWG shielded cable to readers and keypads.
- F. Install minimum No. 12 AWG cable from controller to electrically powered locks. Do not exceed 500 ft. between terminations.
- G. Install minimum No. 18 AWG cable from controller to request-to-exit device and door contact switches. Do not exceed 500 ft. between terminations.
- H. Install minimum No. 12 AWG ac power wire from transformer to controller.

3.5 GROUNDING

- A. Comply with Section 270526 "Grounding and Bonding for Communications 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. Install card readers, keypads, push buttons, and biometric readers.

3.7 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.
- B. 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.

- C. 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 tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 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.

- 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 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. 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 28 15 00

SECTION 28 20 00 – VIDEO SURVEILLANCE

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 a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.
- B. Related Requirements:
 - 1. This Section includes the requirements for a video surveillance system. The video surveillance cameras and associated licensing shall be furnished by the owner and installed by the contractor.
 - 2. The contractor shall provide all mounting hardware and bracketry to properly install the IP cameras.
 - 3. The contractor shall provide all pathways, boxes, and network wiring required to support the IP cameras.
 - 4. The contractor shall provide initial configuration of the camera views for the video client software.

1.3 DEFINITIONS

- A. AGC: Automatic gain control.
- B. BNC: Bayonet Neill-Concelman - type of connector.
- C. B/W: Black and white.
- D. CCD: Charge-coupled device.
- E. FTP: File transfer protocol.
- F. IP: Internet protocol.
- G. LAN: Local area network.
- H. MPEG: Moving picture experts group.
- I. NTSC: National Television System Committee.
- J. PC: Personal computer.
- K. PTZ: Pan-tilt-zoom.

- L. RAID: Redundant array of independent disks.
- M. TCP: Transmission control protocol - connects hosts on the Internet.
- N. UPS: Uninterruptible power supply.
- O. WAN: Wide area network.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Product Warranty: Sample of special warranty.

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: 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 temperatures of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
 - 2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
 - 3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph. Use NEMA 250, Type 3R enclosures.
 - 4. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

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. Comply with NECA 1.
- C. Comply with NFPA 70.

- D. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

2.2 STANDARD CAMERAS – FURNISHED BY OWNER, INSTALLED BY CONTRACTOR.

- A. Interior Fixed Dome (3MP): Pelco Sarix Enhanced IR Dome #IME332-1IRS
- B. Exterior Fixed Dome (3MP): Pelco Sarix Enhanced IR Dome #IME332-1ERS
- C. Interior 180-degree Dome (12MP): Pelco Optera IR Dome #IMM12018-1I
- D. Exterior 180-degree Dome (12MP): Pelco Optera IR Dome #IMM12018-1EI
- E. Interior 270-degree Dome (12MP): Pelco Optera IR Dome #IMM12027-1I
- F. Exterior 270-degree Dome (12MP): Pelco Optera IR Dome #IMM12027-1EI
- G. Interior 360-degree Dome (12MP): Pelco Optera IR Dome #IMM12036-1I

2.3 CAMERA-SUPPORTING EQUIPMENT

- A. Wall Mount Brackets: Aluminum surface mounted bracket, white powder coated finish, IK10 vandal resistant.
- B. Pole Mount Brackets: Aluminum pole mount bracket, white powder coated finish, IK10 vandal resistant, marine grade steel straps.
- C. Corner Mount Brackets: Aluminum corner mount bracket, white powder coated finish, IK10 vandal resistant.
- D. Recessed Ceiling Mount: White plastic camera holder for easy installation into lay-in ceiling tile.
- E. Pendant Mount: Aluminum pipe pendant, white powder coated finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN, WAN, and IP network before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

- A. Wiring Method: Install wiring in raceways unless concealed above lay-in ceiling and supported by J-hooks spaced no more than five feet on center.
- B. 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.
- C. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. For communication wiring, comply with the following:
 - 1. Section 27 15 13 "Communications Copper Horizontal Cabling."
- E. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras and infrared illuminators level and plumb.
- B. Install cameras with 84-inch-minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
- C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.
- D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
- E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
- F. Avoid ground loops by making ground connections only at the control station.
 - 1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.
- G. Identify system components, wiring, cabling, and terminals according to Section 27 0553 "Identification for Communications Systems."
- H. All VMS head-end equipment to be contained within equipment racks.
- I. Provide adequate ventilation for all heat radiating equipment. SSI shall provide fan kits as required to maintain rated operating temperature of installed equipment.
- J. All system equipment and field devices to be held securely in place. Fastenings and supports shall be selected to provide a safety factor of three.

- K. All system equipment equipped with plug in power connectors to be connected to a dedicated receptacle. Do not use tap connectors for plugging in multiple plugs into a single receptacle.
- L. All cable within equipment racks, and cabinets, or on backboards, to be neatly bundled and secured.
- M. Wires shall not be nicked, have strands removed, or have frayed strands when removing insulation or terminating.
- N. Seal-tite flexible conduits, NEMA-rated weatherproof junction boxes connectors shall be utilized for exterior camera locations.

3.4 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. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
 - a. Prepare equipment list described in "Informational Submittals" Article.
 - b. Verify operation of auto-iris lenses.
 - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
 - d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
 - e. Set and name all preset positions; consult Owner's personnel.
 - f. Set sensitivity of motion detection.
 - g. Connect and verify responses to alarms.
 - h. Verify operation of control-station equipment.
 - 3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
 - 4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- C. Video surveillance system will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

3.5 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. Tasks shall include, but are not limited to, the following:
 - 1. Check cable connections.
 - 2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
 - 3. Adjust all preset positions; consult Owner's personnel.
 - 4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
 - 5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 28 20 00

SECTION 28 31 11 – DIGITAL ADDRESSABLE VOICE EVAC FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Heat detectors.
 - 5. Notification appliances.
 - 6. Device guards.
 - 7. Remote annunciator.
 - 8. Addressable interface device.

1.3 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.
- F. VESDA: Very Early Smoke-Detection Apparatus.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, elevations, sections, details, and attachments to other work.

3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Locate detectors according to manufacturer's written recommendations.
13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. The system manufacturer shall furnish to the Contractor a complete wiring diagram of the system for use during construction.
15. Shop drawings for all components and a system wiring diagram showing devices and connections for this building installation shall be submitted for review. Wiring diagrams shall show location of all devices on floor plans and addressable codes adjacent to each device. Addressable codes shall be provided with English messages.

C. General Submittal Requirements:

1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

- a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
- c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
- d. Riser diagram.
- e. Device addresses.
- f. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
- g. Manufacturer's required maintenance related to system warranty requirements.
- h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 1. Notify Architect no fewer than seven days in advance of proposed interruption of fire-alarm service.
 2. Do not proceed with interruption of fire-alarm service without Architect's written permission.
- B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.

2. Warranty Period: Five years from date of Substantial Completion.

1.10 SYMTOM MONITORING

- A. A Monitoring Contract will be established "By the Contractor" for one (1) year through the Owner's current monitoring company (F.E. Moran) for setting up monitoring service. Coordinate monitoring company with Owner prior to entering into a contract. Contractor to provide paperwork for the Owner to fill out and return. The contractor will include a check to the monitoring company to pay for the first one (1) year of monitoring service including any associated costs for them to come out to the site to furnish and install and program the wireless/cellular transceiver units and Internet Communication Module. Primary monitoring will be by Internet and Secondary by Cellular Service. Contract Date to commence upon Main Panel being changed out to New System and upon Owner's Acceptance of System.

1. For F.E. Moran work, contact: Adam Kimball, akimball@femoranssecurity.com, (217) 306-6271.

1.11 SYSTEM MONITORING

- A. A Monitoring Contract will be established by the owner with the owner's current monitoring company (F.E. Moran). Coordinate the establishment of the monitoring with monitoring company and owner. The contractor will include all costs associated with F.E. Moran coming out to the site and furnishing, installing and programing the wireless/cellular transceiver units and Internet Communication Module. Primary monitoring will be by Internet and Secondary by Cellular Service.

1. For F.E. Moran work, contact: Adam Kimball, akimball@femoranssecurity.com, (217) 306-6271.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice / strobe evacuation.
- B. Automatic sensitivity control of certain smoke detectors.
- C. All components provided shall be listed for use with the selected system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
 1. Manual stations.
 2. Heat detectors.
 3. Smoke detectors.
 4. Duct smoke detectors.
 5. Carbon monoxide detectors.

6. Automatic sprinkler system water flow.
- B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances.
 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 5. Record events in the system memory.
 6. Indicate device in alarm on the graphic annunciator.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. Loss of communication with any panel on the network.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 4. Loss of primary power at fire-alarm control unit.
 5. Ground or a single break in internal circuits of fire-alarm control unit.
 6. Abnormal ac voltage at fire-alarm control unit.
 7. Break in standby battery circuitry.
 8. Failure of battery charging.
 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
- E. System Supervisory Signal Actions:
1. Initiate notification appliances.
 2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
 3. Record the event on system printer.
 4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
 5. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways 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 and the unit will be fully operational after the seismic event."

2.4 FIRE-ALARM CONTROL UNIT

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

1. Notifier.
- B. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
1. Pathway Class Designations: NFPA 72, Class B.
 2. Install no more than 80 percent of total circuit capacity of addressable devices on each signaling-line circuit.
 3. Serial Interfaces:
 - a. One dedicated RS 485 port for remote station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - c. One USB port for PC configuration.
- E. Notification-Appliance Circuit:
1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
 3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

- F. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.
- G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries: Sealed lead calcium.
- J. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - 2. Station Reset: Key- or wrench-operated switch.
 - 3. Provide indoor protective shield for each pull station in the gymnasium: Factory fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

2.6 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268; operating at 24-V dc, nominal.
 - 2. Detectors shall be two-wire type.
 - 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

5. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

B. Photoelectric Smoke Detectors:

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. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: 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. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.
7. Remote Indicator and Test Station: LED status indicator and key switch to initiate alarm for testing.

2.7 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.8 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
 - 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.9 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- B. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - 4. Flashing shall be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, red.
- C. Exterior fire alarm speaker and visible notification appliance.
 - 1. Combination unit.
 - 2. Weatherproof, outdoor rated.
 - 3. Wall-mounted, unless otherwise indicated.
 - 4. Horn Output: 90 dBA, measured 10 feet from horn.
 - 5. Light Output: 110 cd.

2.10 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.11 ADDRESSABLE INTERFACE DEVICE

- A. General:
 - 1. Include address-setting means on the module.
 - 2. Store an internal identifying code for control panel use to identify the module type.
 - 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown.
 - 1. Allow the control panel to switch the relay contacts on command.
 - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
 - 1. Operate notification devices.
 - 2. Operate solenoids for use in sprinkler service.

2.12 DEVICE GUARDS

- A. Furnish wireguards for fire alarm devices installed in gymnasiums.
- B. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 - 1. Factory fabricated and furnished by device manufacturer.
 - 2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.
 - 3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
 - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
 - 2. Specific care should be taken in the location of duct-type sampling tubes and associated housing to allow for proper operation, testing and inspection. Where ductwork is visible, such as mechanical rooms, the detector shall be located in ductwork to allow the alarm indicating LED to be viewed from a common passage in room. Where detector cannot be located in ductwork to be viewed from a common passage, a remote alarm indicator LED, test and reset assembly shall be provided on wall near detector for ease of locating detector in alarm condition. Actual location shall be confirmed by manufacturer as to duct width, filters, air velocities and bends in ductwork.

3. Duct detectors shall be mounted and checked prior to the start of any wiring. Checking for proper operation shall be done by the equipment supplier with a pressure differential meter. The differential pressure readings shall be between 0.04 and 1.30" of water as indicated on the differential pressure meter. If acceptable differential pressure readings are not obtained, the inlet sampling tube shall be replaced or modified by the equipment supplier until proper differential pressure readings are obtained. If inlet sampling tube replacement or modifications do not yield proper differential pressure readings, the duct detector assembly shall be relocated at no additional cost to the Owner. Wiring of duct detectors shall commence only after proper differential pressure readings have been obtained.
 4. It shall be the responsibility of this contractor to ensure associated dampers close or associated air handling units are shut down upon detection of smoke by any duct mounted smoke detector.
- F. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.
- G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- H. Visible Alarm-Indicating Devices: Install at 80" above the highest floor level in the space or 6 inches below the ceiling, whichever is lower. Install all devices at the same height unless otherwise indicated.
1. Adjust field selectable intensity level as called for on the drawings. Where specific intensity rating is not shown or noted on the drawings, set intensity per NFPA 72 requirements.
- I. Smoke Detectors:
1. Coordinate locations of ceiling mounted smoke detectors with lights, sprinklers, HVAC grilles and diffusers and all other ceiling mounted devices and appliances.
 2. Locate all smoke detectors so that there is a minimum of 36" between the smoke detector and nearest HVAC air distribution or return device.
 3. Coordinate locations of smoke detectors in elevator shafts, pits and machine rooms with sprinkler locations. Locate smoke detector within 24" of each sprinkler head.
- J. Fire Alarm System Wiring
1. Wiring Method: Install wiring in conduit when exposed in unfinished spaces, mechanical spaces, or in spaces where wiring would be subject to damage (gymnasiums etc). In accessible ceiling spaces or crawl space wiring shall be permitted to be installed on a system of J-hooks. All branch wiring to individual devices in new construction shall be in conduit concealed in new walls. All branch wiring to individual devices in existing construction shall be in surface mounted raceway - Wiremold #500 or similar.
 2. All rough-in boxes and junction boxes shall be of sufficient size for the conduit and conductors entering the same.
 3. All wiring shall be in accordance with the manufacturer's wiring diagram and recommendations.
 4. All wiring shall be multiple conductor cables with individually insulated conductors and outer vinyl jacket. The individual conductors shall be color coded throughout the system.
 5. All connections and power sources introduced into the fire alarm system via the auxiliary contacts of the smoke detectors and addressable interface modules shall be in strict accord with the fire alarm manufacturer's requirements and recommendations.
 6. The sprinkler system flow switches will be provided by others. Wire flow switches into the system through addressable interface modules.
 7. The following is a general description of the system wiring requirements:

- a. Addressable Device Circuits: Two conductor, #18 AWG, twisted, shielded, cable.
 - b. Audible Alarm Circuit: Two conductor, #14 AWG, cable.
 - c. Visual Alarm Circuit: Two conductor, #14 AWG, cable.
 - d. Audible / Visual Alarm Circuit: Two conductor, #14 AWG, cable.
 - e. Speaker Circuit: Two conductor, #14 AWG, twisted, shielded, audio cable.
 - f. 24 VDC Device Power: Two conductor, #14 AWG, cable.
 - g. Fan Stop Wiring: Two conductor, #14 AWG, THHN.
- K. Exterior Alarm Indicating Device: Provide exterior mounted fire alarm horn and visible indicating device. Unless otherwise shown or noted on the drawings, install the device at the Fire Department connection to the sprinkler system. Mount at 10 feet above finished grade unless architectural features require lower height, minimum mounting height: 8 feet, 6 inches above finished grade.

3.3 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
- 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
- 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Magnetically held-open doors.
 - 3. Electronically locked doors and access gates.
 - 4. Alarm-initiating connection to elevator recall system and components.
 - 5. Supervisory connections at valve supervisory switches.
 - 6. Supervisory connections at elevator shunt-trip breaker.
 - 7. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by:
 - 1. Architect / Engineer's Representative.
 - 2. Owner's Representative.
 - 3. Fire Alarm Manufacturer's Service Representative.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.7 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.8 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software 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 access to system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 11

SECTION 28 32 00 – RESCUE ASSISTANCE COMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: All required components, devices, conduit, cable, and labor necessary for the complete and successful installation of a Rescue Assistance Audio/Visual Communication system including but not limited to the following:
 - 1. Main Control Panel.
 - 2. Control Panel Power Supply with Battery Backup.
 - 3. Remote Stations.
 - 4. System cabling.
- B. Related Sections:
 - 1. Section 27 1313 "Communications Copper Backbone Cabling" for Category 5e, 6, and 7 backbone (riser-rated) cabling.

1.3 ACTION SUBMITTALS

- A. Product Data: Component details including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
 - 1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration.
 - 2. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
 - 3. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.

- C. Product Warranty: Sample of special warranty.
- D. Field Test Reports: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications.
- E. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For rescue assistance communications system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
 - 1. Data for each type of product, including features and operating sequences.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project. Installer shall be:
 - a. Currently certified by BICSI as an RCDD.
 - b. A licensed electrician
- B. Testing Agency Qualifications:
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing or be a licensed electrician.

1.7 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 fail 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. Manufacturers:
 - 1. Cornell
 - 2. Tektone

3. Jeron
- B. Description: System shall be open-voice, selective calling type, with individual selector switches for each station and shall have the capability of accepting a remote Annunciator.
- C. Capacity shall be a minimum of (8) stations / zones
- D. Main Control Panel:
 1. Description: Actual panel shall be flush-mounted and constructed out of either aluminum or stainless steel. It shall have instructions for responding personnel in clear and factory-produced text on face of panel.
 2. Indicators shall include POWER ON and ZONE INDICATORS (with incoming call, station active and line fault conditions).
 3. Switches shall include PUSH TO TALK / RELEASE TO LISTEN, GLOBAL ZONE RESET, and ZONE SELECTOR buttons.
 4. Integrated speaker and microphone assembly behind protected steel baffle.
 5. Control Panel "press-to-talk, release-to-listen" operation, with hands free communications at the remote / called station. Panel shall have a steady indicator for a placed call and a slow, repetitive audible alarm from integrated speaker for each unanswered or unacknowledged call.
 6. If wiring to zone somehow becomes corrupt (short, open, etc.), indicator at appropriate zone shall illuminate, noting need for service.
- E. Power Supply
 1. Description: Surface-mounted, UL-listed (as signaling equipment), lockable power supply with battery back-up.
 2. Power Requirements: 115VAC/60Hz input voltage; 24VDC nominal output voltage (3A minimum) – confirm with manufacturer. Supply shall have short circuit and thermal overload protection.
 3. Terminations: via integrated screw terminal.
 4. Back-up / Redundant Power: provide batteries to provide 30 minutes (minimum) of backup power to supply (and further, Control Panel) in case of power outage.
 5. Indicators: NORMAL OPERATING CONDITION, AC POWER LOSS, DC OUTPUT LOSS, AC POWER LOSS (DISCHARGED) / DC OUTPUT LOSS.
- F. Remote Station
 1. Description: Vandal-proof, flush-mounted unit providing clear two-way, hands-free communication and call initiation to the Control Panel.
 2. Stainless steel construction (12-gauge minimum).
 3. Round, smooth, flush tamper-resistant stainless-steel mechanical (SPST) pushbutton.
 4. Switches and Speaker shall be moisture- and puncture resistant.
 5. Multiple-layer steel baffle (protects speaker from tampering).
 6. Power: Supplied by Control Panel.
 7. Communication: Hands-free at station (after call is initiated), Control Panel is Push-to-Talk, Release-to-Listen.
 8. Physical: Provide appropriately sized backbox by same manufacturer for recessed mounting. Mounting hardware shall be tamper-resistant.
 9. Identification: remote station must have directions clearly identified and factory-produced on face of unit, i.e. "PUSH FOR HELP" and "CALL RECEIVED operation".

G. System Cabling

1. General: Provide all cabling as recommended by manufacturer. Cabling is indicated on System One-Line Diagram, but varies by manufacturer.
2. Rating: All cabling shall be riser-rated and shall be installed in conduit.
3. Conductor Size: Observe manufacturer's recommended cabling distance limitations and size cabling accordingly.

2.2 SEQUENCE OF OPERATION

- A. Remote station momentary pushbutton connects call station to Control Panel – single pulse tone and flashing light signals to caller that the alarm has been received.
- B. Signal also transmitted to public telephone line via dialer module.
- C. Control Panel indicates zone (or zones) call has been initiated from. Responding personnel pushes ZONE button.
- D. Responding personnel then selects TALK button and voice communication is established for indefinite time – LED at panel indicate talkpath has been established and incoming conversation path is amplified. Upon completion, the ZONE button is depressed again.
- E. If more than one zone is signaling, Control Panel accepts the call or calls in the same manner as described above.
- F. When or if the emergency situation is resolved, the Control Station operator selects

2.3 INDICATORS

- A. NORMAL (i.e. STANDBY) MODE: Control Panel and Remote Station – no light and no tone.
- B. ALARM TRANSMIT: Control Panel – steady LED, intermittent tone; Remote Station – steady LED, single tone.
- C. ALARM ACKNOWLEDGED: Control Panel – intermittent (flashing) LED; Remote Station – intermittent LED, single tone/
- D. INTERCOM ON: Control Panel – steady LED at TALK button; Remote Station – no indicators.
- E. INTERCOM OFF: Control Panel and Remote Station – intermittent LED (at zone and call button, respectively).
- F. WIRING FAULT: Control Panel (only) – LED near ZONE button, intermittent tone.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of intrusion detection.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SYSTEM INSTALLATION

- A. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 27 0548.16 "Seismic Controls for Communications Systems."

3.3 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceways according to Section 27 0528 "Pathways for Communications Systems," except in accessible indoor ceiling spaces where cable may be installed in free-air on j-hooks spaced no more than five ft. on center. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. 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.
- C. 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 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
 - 4. Data and Television Signal Transmission Cables: Install according to Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. 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.
- F. 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 27 0553 "Identification for Communications Systems."

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 27 0553 "Identification for Communications Systems."
- B. Install instructions frame in a location visible from master control unit.

3.5 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. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 27 0526 "Grounding and Bonding for Communications Systems."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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: Perform a complete functional system test per manufacturer's written instructions.
- C. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the rescue assistance communication system.

END OF SECTION 28 31 00

SECTION 32 13 13 - CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Concrete sidewalks and parking areas

1.02 RELATED REQUIREMENTS

- A Section 03 10 00 - Concrete Forming and Accessories.
- B Section 03 30 00 - Cast-in-Place Concrete.
- C Section 07 92 00 - Joint Sealants: Sealing joints.
- D Section 09 91 13 - Exterior Painting: Pavement markings.
- E Section 32 17 13 - Parking Bumpers: Precast concrete parking bumpers.
- F Section 32 17 23 - Pavement Markings.

1.03 REFERENCE STANDARDS

- A ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete 1991 (Reapproved 2009).
- B ACI 301 - Specifications for Concrete Construction 2020.
- C ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- D ACI 305R - Guide to Hot Weather Concreting 2020.
- E ACI 306R - Guide to Cold Weather Concreting 2016.
- F ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2022.
- G ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete 2018a.
- H ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
- I ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.
- J ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete 2022.
- K ASTM C150/C150M - Standard Specification for Portland Cement 2022.
- L ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2019.
- M ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete 2019, with Editorial Revision (2022).
- N ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) 2018.
- O ASTM D1752 - Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction 2018.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide data on joint filler, admixtures, and curing compound.
- C Design Data: Indicate pavement thickness, designed concrete strength, reinforcement, and typical details.

PART 2 PRODUCTS

2.01 PAVING ASSEMBLIES

- A Comply with applicable requirements of ACI 301.

- B Concrete Sidewalks and Median Barrier: 3,000 psi 28 day concrete, 4 inches thick, match existing color Portland cement.

2.02 FORM MATERIALS

- A Form Materials: As specified in Section 03 10 00, comply with ACI 301.
- B Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
 - 1. Thickness: 1/2 inch.

2.03 REINFORCEMENT

- A Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) yield strength; deformed billet steel bars; unfinished.
- B Steel Welded Wire Reinforcement: Plain type, ASTM A1064/A1064M; in flat sheets; unfinished.
- C Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi yield strength; deformed billet steel bars; unfinished finish.

2.04 CONCRETE MATERIALS

- A Concrete Materials: As specified in Section 03 30 00.
- B Fiber Reinforcement: Synthetic fibers shown to have long-term resistance to deterioration when in contact with alkalis and moisture; 1/2 inch length.

2.05 ACCESSORIES

- A Curing Compound: ASTM C309, Type 1, Class A.
- B Liquid Surface Sealer: [_____].
- C Surface Retarder:
- D Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
 - 1. Material: ASTM D1751, cellulose fiber.

2.06 CONCRETE MIX DESIGN

- A Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.

2.07 MIXING

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B Verify gradients and elevations of base are correct.

3.02 SUBBASE

- A See Section 32 11 23 for construction of base course for work of this Section.

3.03 PREPARATION

- A Moisten base to minimize absorption of water from fresh concrete.
- B Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.

3.04 FORMING

- A Place and secure forms to correct location, dimension, profile, and gradient.

B Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

A Place reinforcement at top of slabs-on-grade.

B Interrupt reinforcement at contraction joints.

C Place dowels to achieve pavement and curb alignment as detailed.

3.06 COLD AND HOT WEATHER CONCRETING

A Follow recommendations of ACI 305R when concreting during hot weather.

B Follow recommendations of ACI 306R when concreting during cold weather.

C Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.07 PLACING CONCRETE

A Place concrete in accordance with ACI 304R.

B Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.

C Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

3.08 JOINTS

A Place 3/8 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.

1. Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.

B Provide scored joints.

1. Between sidewalks and curbs.

2. Between curbs and pavement.

C Saw cut contraction joints 3/16 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab.

3.09 FINISHING

A Area Paving: Light broom, texture perpendicular to pavement direction.

3.10 TOLERANCES

A Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.

B Maximum Variation From True Position: 1/4 inch.

3.11 FIELD QUALITY CONTROL

A Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.

1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

3.12 PROTECTION

A Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

END OF SECTION 32 13 13

SECTION 32 17 13 - PARKING BUMPERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Precast concrete parking bumpers and anchorage.

1.02 RELATED REQUIREMENTS

- A Section 32 17 23 - Pavement Markings.

1.03 REFERENCE STANDARDS

- A ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2022.
- B ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
- C ASTM C150/C150M - Standard Specification for Portland Cement 2022.
- D ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
- E ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete 2017a.

1.04 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide unit configuration, dimensions.

PART 2 PRODUCTS

2.01 MATERIALS

- A Parking Bumpers: Precast concrete, complying with the following:
 1. Profile: Manufacturer's standard.
 2. Cement: ASTM C150/C150M, Portland Type I - Normal; white color.
 3. Concrete Materials: ASTM C330/C330M aggregate, water, and sand.
 4. Reinforcing Steel: ASTM A615/A615M, deformed steel bars; unfinished, strength and size commensurate with precast unit design.
 5. Air Entrainment Admixture: ASTM C260/C260M.
 6. Concrete Mix: Minimum 5,000 psi compressive strength after 28 days, air entrained to 5 to 7 percent.
 7. Use rigid molds, constructed to maintain precast units uniform in shape, size and finish. Maintain consistent quality during manufacture.
 8. Embed reinforcing steel, and drill or sleeve for two dowels.
 9. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
 10. Minor patching in plant is acceptable, providing appearance of units is not impaired.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install units without damage to shape or finish. Replace or repair damaged units.
- B Install units in alignment with adjacent work.
- C Fasten units in place with 2 dowels per unit.

END OF SECTION 32 17 13

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A Painted pavement markings.

1.02 RELATED REQUIREMENTS

A Section 32 13 13 - Concrete Paving.

B Section 32 17 13 - Parking Bumpers.

1.03 REFERENCE STANDARDS

A AASHTO M 237 - Standard Specification for Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete 2005 (Reapproved 2019).

B AASHTO M 249 - Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form) 2012 (Reapproved 2020).

C AASHTO MP 24 - Standard Specification for Waterborne White and Yellow Traffic Paints 2015 (Reapproved 2020).

D FHWA MUTCD - Manual on Uniform Traffic Control Devices 2010, with Errata.

1.04 ADMINISTRATIVE REQUIREMENTS

A Coordination: Coordinate the work of this section with adjoining work.

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

1.05 SUBMITTALS

A See Section 01 30 00 - Administrative Requirements for submittal procedures.

B Shop Drawings: Indicate survey control points and pavement markings.

C Product Data: Manufacturer's data sheets on each product to be used.

D Certificates: Submit for each batch stating compliance with specified requirements.

1. Painted pavement markings.

E Manufacturer's Instructions:

1. Preparation instructions and recommendations.

2. Storage and handling requirements and recommendations.

3. Installation methods.

F Installer's qualification statement.

G Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 60 00 - Product Requirements for additional provisions.

2. Extra Paint: 2 containers, 1 gallon size, of each type and color.

1.06 QUALITY ASSURANCE

A Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

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

1.07 DELIVERY, STORAGE, AND HANDLING

A Store products in manufacturer's unopened packaging until ready for installation.

B Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.08 FIELD CONDITIONS

A Do not install products under environmental conditions outside manufacturer's absolute limits.

- 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.

1.09 SEQUENCING

- A Allow new pavement surfaces to cure for a period of not less than 14 days before application of markings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Painted Pavement Markings:

2.02 PAINTED PAVEMENT MARKINGS

- A Comply with State of Illinois Highway Department standards.
- B Comply with FHWA MUTCD.
- C Painted Pavement Markings: As indicated on drawings.
 - 1. Marking Paint: In accordance with AASHTO MP 24.
 - a. Parking Lots: Yellow.
 - b. Symbols and Text: White.
 - c. Wheelchair Symbols: Provide blue and white.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verification of Conditions: Verify that pavement is dry and ready for installation.
- B Notify Architect of unsatisfactory conditions before proceeding.

3.02 PREPARATION

- A Establish survey control points for locating and dimensioning of markings.
- B Clean surfaces prior to installation.
 - 1. Remove dust, dirt, and other debris.
 - 2. Remove rubber deposits, existing paint markings, and other coatings.
- C Apply paint stencils by type and color at necessary intervals.

3.03 INSTALLATION

- A General:
 - 1. Position pavement markings as indicated on drawings.
 - 2. Field location adjustments require approval of Architect.
- B Painted Pavement Markings:
 - 1. Apply in accordance with manufacturer's instructions.
 - 2. Apply in accordance with FHWA MUTCD standards.
 - 3. Marking Paint: Apply uniformly, with sharp edges.
 - a. Applications: One coat.
 - b. Wet Film Thickness: 0.015 inch, minimum.
 - c. Stencils: Lay flat against pavement, align with striping, remove after application.

3.04 TOLERANCES

- A Maximum Variation From True Position: 3 inches (76 mm).
- B Maximum Offset From True Alignment: 3 inches (76 mm).

3.05 FIELD QUALITY CONTROL

- A See Section 01 40 00 - Quality Requirements for additional requirements.
- B Perform field inspection for deviations from true alignment or material irregularities.
- C If inspections indicate work does not meet specified requirements, rework and reinspect at no cost to Owner.

D Allow the pavement marking to set at least the minimum time recommended by manufacturer.

3.06 CLOSEOUT ACTIVITIES

3.07 PROTECTION

A Replace damaged or removed markings at no additional cost to Owner.

B Preserve survey control points until pavement marking acceptance.

END OF SECTION 32 17 23

SECTION 32 31 19 - DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Decorative steel fences.
- B Decorative aluminum fences.
- C Automatic gate operators are specified in another section.

1.02 RELATED REQUIREMENTS

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

1.03 REFERENCE STANDARDS

- A ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes 2017.
- B ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- D ASTM D2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact) 1993 (Reapproved 2019).
- E ASTM D3359 - Standard Test Methods for Rating Adhesion by Tape Test 2022.
- F ASTM F2200 - Standard Specification for Automated Vehicular Gate Construction 2020.
- G ASTM F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets 2016.
- H NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

- A See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B Product Data: Submit 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:
 - 1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
- D Samples: Submit two samples of fence panels, slat infill, 6 inch by 6 inch in size illustrating construction and colored finish.
- E Manufacturer's Installation Instructions: Indicate installation requirements, post foundation anchor bolt templates, and [_____].
- F Manufacturer's Qualification Statement.
- G Installer's Qualification Statement.
- H Field Inspection Records: Provide installation inspection records that include post settings, framework, fittings and accessories, gates, and workmanship.
- I Manufacturer's Warranty.
- J Maintenance Materials: Furnish the following for Owner's use in maintenance of project:

1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.07 DELIVERY, STORAGE AND HANDLING

- A Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.08 WARRANTY

- A Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Decorative Metal Fences and Gates:
- B Automatic Gate Operators: specified under parking control equipment

2.02 FENCES

- A Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
 1. Capable of resisting vertical load, horizontal load and infill performance requirements for fence categories defined in ASTM F2408.
- B Electro-Deposition Coating: Multistage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
 1. Total Coating Thickness: 2 mils, minimum.
 2. Color: As selected by Architect from manufacturer's standard range.
 3. Coating Performance: Comply with general requirements of ASTM F2408.
 - a. Adhesion: ASTM D3359 (Method B); Class 3B with 90 percent or more of coating remaining in tested area.
 - b. Impact Resistance: ASTM D2794; 60 inch pounds.
- C Steel: ASTM A653/A653M; tensile strength 45,000 psi, minimum.
 1. Hot-dip galvanized; ASTM A653/A653M, G60.
 2. 62 percent recycled steel, minimum.
- D Aluminum: ASTM B221.
 1. Tubular Pickets, Rails and Posts: 6005-T5 alloy.
 2. Extrusions for Posts and Rails (Outer Channel): 6005-T5 alloy.
 3. Extrusions for Pickets and Rail (Inner Slide Channels): 6063-T5 alloy.
- E Fasteners: ASTM A276/A276M, Type 302 stainless steel; finished to match fence components.

2.03 MECHANICALLY FASTENED STEEL FENCE

- A Provide fence meeting requirements for Industrial class as defined by ASTM F2408.
- B Fence Panels: Mechanically fastened with internal reinforcement and tamperproof fasteners; 12 feet high by 6 feet long.
 1. Panel Strength: Capable of supporting 600 pound load applied at midspan without deflection.
 2. Attach panels to posts with manufacturer's standard panel brackets.
- C Posts: Steel tube.
 1. Size: 4 inches square by 12 gauge, 0.1094 inch, with manufacturer's standard cap.

- 2. Post Cap: Ball.
 - D Rails: Manufacturer's standard, double-wall steel channel; 1-3/4 inch square by 14 gauge, 0.0747 inch with pre-punched picket holes.
 - 1. Picket Retaining Rods: 1/8 inch galvanized steel.
 - 2. Picket-to-Rail Intersection Seals: PVC grommets.
 - E Louver type screening: Shadow 100 (Amteco)
 - 1. Spacing: 4.175 inch on center.
 - 2. Size: 1 inch square by 14 gauge, 0.0747 inch
 - 3. Style: Pickets with finial extend above top rail.
 - 4. Finial: Spear point.
 - F Flexibility: Capable of following variable slope of up to 1:4.
 - G Color: To be selected by Architect from manufacturer's standards.
- 2.04 ALUMINUM FENCE
- A Decorative Aluminum Fence System: Provide fence meeting the Test Load and Coating Performance requirements of ASTM F2408 for Industrial class.
 - 1. Fence Panels: 4 feet high by 6 feet long.
 - a. Panel Style: Two rail.
 - b. Panel Strength: Capable of supporting 270 pounds minimum load applied at midspan without deflection.
 - c. Attach panels to posts with manufacturer's standard panel brackets and recommended fasteners.
 - d. Posts: Aluminum extrusions; 2-1/2 inches square.
 - e. Rails: Extruded aluminum channels.
 - 1) Double-walled aluminum U-channel; outside cross-section dimensions of 1-3/4 inch square; interior guide channel forms lower limit of raceway for retaining rod.
 - 2) Enclosed Retaining Rod: 1/8 inch diameter galvanized steel with variable pitch connection system for high angle racking and elimination of external fasteners.
 - 3) Picket-to-Rail Intersection Seals: PVC grommets.
 - f. Pickets: Extruded aluminum tubes.
 - 1) Size: 1-1/4 inch square.
 - 2) Style: Pickets with finial extend above top rail.
 - g. Fasteners: Manufacturer's standard stainless steel bolts, screws, and washers; factory finish fasteners to match fence.
 - h. Accessories: Aluminum castings, extrusions, and cold-formed strips; factory finished to match fence.
 - 1) Flat post cap.
 - i. Color: As selected by Architect from manufacturer's standard range.
 - j. Products:
 - B Decorative Aluminum Fence System:
 - 1. Fence Panels: 4 feet high by 6 feet long.
 - a. Attach panels to posts with manufacturer's standard panel brackets and recommended fasteners.
 - b. Posts: Manufacturer's standard; extruded aluminum tubes.
 - c. Rails: Manufacturer's standard; extruded aluminum channels.

- d. Pickets: Manufacturer's standard; extruded aluminum tubes.
 - 1) Style: Flat top.
- e. Fasteners: Manufacturer's standard stainless steel bolts, screws, and washers; factory finish fasteners to match fence.
- f. Accessories: Aluminum castings, extrusions and cold-formed strips; factory finished to match fence.
- g. Color: As selected by Architect from manufacturer's standard range.

2.05 SPECIALITY HARDWARE

- A Hinges: Finished to match fence components.
 - 1. Closing: Manual.
 - 2. Material: Steel.

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION

- A Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Set fence posts in accordance with the manufacturer recommended spacing.
- C When cutting rails immediately seal the exposed surfaces by:
 - 1. Removing metal shavings from cut area.
 - 2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
 - 3. Apply two coats of custom finish spray paint matching fence color.
 - 4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.

3.04 TOLERANCES

- A Maximum Variation From Plumb: 1/4 inch.
- B Maximum Offset From Indicated Position: 1 inch.
- C Minimum Distance from Property Line: 6 inches.

3.05 FIELD QUALITY CONTROL

- A See Section 01 40 00 - Quality Requirements, for additional requirements.
- B Gates: Inspect for level, plumb, and alignment.
- C Workmanship: Verify neat installation free of defects.

3.06 CLEANING

- A Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- B Clean fence with mild household detergent and clean water rinse well.
- C Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.07 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 32 31 19