

EXHIBIT H

CONSTRUCTION SPECIFICATIONS



TOYOTA PARK TRANSIT CENTER PHASE II

7000 S. HARLEM AVENUE
BRIDGEVIEW, ILLINOIS 60455

FINAL DESIGN

November 27th, 2017

Studio ARQ, LLC. (AOR)
329 W. 18th St.- Suite 904A
Chicago, IL 60616

INTENTIONALLY LEFT BLANK

CONTACT LIST

CLIENT:

Village of Bridgeview

7500 S. Oketo Ave.
Bridgeview, IL 60455

Pace Suburban Bus

550 W. Algonquin Road
Arlington Heights, IL 60005

ARCHITECTS:

Studio ARQ, LLC. (AOR)
329 W. 18th St.- Suite 904A
Chicago, IL 60616
312.846.6415
Cesar Santoy, AIA

UrbanWorks, Ltd.
213 W. Institute Place- Suite 710
Chicago, IL 60610
312.202.1200
Patricia Saldaña-Natke, AIA

ENGINEERS:

Robinson Engineering, Ltd.
17000 S. Park Ave.
South Holland, IL 60473
708.331.6700
Patricia Barker

CE Anderson & Associates
175 N. Franklin Ave.- Suite 410
Chicago, IL 60606
312.750.1704
Charles Anderson

M.E.P. Infrastructure Solutions, Inc.
440 S La Salle St., Suite 3000B
Chicago, IL 60605
312.279.1185
Santos A. Torres

INTENTIONALLY LEFT BLANK

TOYOTA PARK TRANSIT CENTER - PHASE II

The following list of documents comprises Exhibit H- construction Specifications for the project listed above. Where numeric sequence of sections is interrupted, such interruptions are intentional.

The complete Construction Specifications for this project consists of this entire Volume, which must not be separated for any reason. The Architect and Owners disclaim any responsibility for any assumptions made by a contractor or subcontractor who does not receive a complete Volume, including all section listed in the Table of Contents.

TABLE OF CONTENTS

DIVISION 1- GENERAL REQUIREMENTS (NOT USED)

01100	Summary	SA/UW	11/27/17
-------	---------	-------	----------

DIVISION 2- SITE CONSTRUCTION

02100	Site Amenities	SA/UW	11/27/17
02315	Excavation and Fill	RE	11/27/17
02370	Erosion and Sedimentation Control	RE	11/27/17
02725	Aggregate Base Course	RE	11/27/17
02775	Sidewalks	RE	11/27/17
02830	Chain Link Fencing (Temporary Panels)	SA	11/27/17
02920	Lawns and Grasses	RE	11/27/17

DIVISION 3- CONCRETE

03300	Cast-In-Place Concrete	CEA&A	11/27/17
-------	------------------------	-------	----------

DIVISION 4- MASONRY

04200	Concrete Unit Masonry	SA/UW	11/27/17
-------	-----------------------	-------	----------

DIVISION 5- METALS

05120	Structural Steel	CEA&A	11/27/17
05192	Engineered Light Gauge Metal Trusses	CEA&A	11/27/17
05310	Steel Decking	CEA&A	11/27/17
05400	Cold-Formed Metal Framing	SA/UW	11/27/17

DIVISION 6- WOOD AND PLASTICS

06160	Sheathing	SA/UW	11/27/17
-------	-----------	-------	----------

DIVISION 7- THERMAL AND MOISTURE PROTECTION

07210	Thermal Insulation	SA/UW	11/27/17
07271	Self-Adhesive Air/Vapor Barriers	SA/UW	11/27/17
07411	Metal Roof Panels	SA/UW	11/27/17
07413	Metal Panels	SA/UW	11/27/17
07920	Joint Sealants	SA/UW	11/27/17

DIVISION 8- DOORS AND WINDOWS

08111	Hollow Metal Doors and Frames	SA/UW	11/27/17
08311	Access Doors and Frames	SA/UW	11/27/17
08451	Plastic Glazing	SA/UW	11/27/17
08710	Door Hardware	SA/UW	11/27/17
08900	Glazed Curtain Wall	SA/UW	11/27/17

08901	Glazed Curtain Wall (Alternative Full Height Bid)	SA/UW	11/27/17
-------	---	-------	----------

DIVISION 9- FINISHES

09300	Tile	SA/UW	11/27/17
09670	Fluid Applied Floor Finish	SA/UW	11/27/17
09911	Exterior Painting	SA/UW	11/27/17
09912	Interior Painting	SA/UW	11/27/17

DIVISION 10- SPECIALTIES

10801	Toilet Accessories	SA/UW	11/27/17
10813	Warm Air Hand Dryer	SA/UW	11/27/17
10820	Treillage	SA/UW	11/27/17

DIVISION 15- MECHANICAL

15010	General Provisions for Mechanical Work	MEPIS	11/27/17
15050	Basic Mechanical Materials and Methods	MEPIS	11/27/17
15060	Hangers and Supports	MEPIS	11/27/17
15074	Vibration Control for HVAC Equipment		
15082	Plumbing Insulation	MEPIS	11/27/17
15083	HVAC Insulation	MEPIS	11/27/17
15110	Valves	MEPIS	11/27/17
15140	Domestic Water Piping	MEPIS	11/27/17
15145	Domestic Water Piping Specialties	MEPIS	11/27/17
15150	Sanitary Waste and Vent Piping	MEPIS	11/27/17
15155	Drainage Piping Specialties	MEPIS	11/27/17
15160	Storm Drainage Piping	MEPIS	11/27/17
15410	Plumbing Fixtures	MEPIS	11/27/17
15766	Electric Wall and Ceiling Heaters	MEPIS	11/27/17
15769	Electric Infrared Heaters	MEPIS	11/27/17
15815	Metal Ducts	MEPIS	11/27/17
15820	Duct Accessories	MEPIS	11/27/17

DIVISION 16- ELECTRICAL

16051	Common Work Results for Electrical	MEPIS	11/27/17
16060	Grounding and Bonding	MEPIS	11/27/17
16073	Hangers and Supports for Electrical Systems	MEPIS	11/27/17
16075	Electrical Identification	MEPIS	11/27/17
16118	Underground Ductbanks and Raceways	MEPIS	11/27/17
16120	Conductors and Cables	MEPIS	11/27/17
16130	Raceways and Boxes	MEPIS	11/27/17
16140	Wiring Devices	MEPIS	11/27/17
16145	Lighting Control Devices	MEPIS	11/27/17
16410	Enclosed Switches and Circuit Breakers	MEPIS	11/27/17
16420	Enclosed Controllers	MEPIS	11/27/17
16442	Panelboards	MEPIS	11/27/17
16511	Interior Lighting	MEPIS	11/27/17

Toyota Park Geotechnical Report

Geotechnical Engineering Report – Dated 17 January 2011

“IDOT Required Special Provisions for Roadway Lighting”

END OF SECTION TABLE OF CONTENTS

SECTION 01100 – SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Work covered by the Contract Documents.
2. Use of premises.
3. Work restrictions.
4. Supplemental Substantial Completion Requirements

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Identification: Toyota Park Transit Center Phase II

1. Project Location: 7000 S. Harlem Avenue, Bridgeview, IL 60455

B. Owner: Pace the Suburban Bus Division of the Regional Transportation Authority.

1. Owner's Project Manager: Tom Rasmussen

C. The Work consists of the following:

1. The Work consist of site improvements, including existing concrete sidewalk removal and replacement, and grading,
2. An approximately 2,350 square foot structural steel canopy structure housing an approximately 225 square foot masonry utility building and an approximately 450 square foot semi-enclosed glass waiting area, erected on cast in place concrete foundations. The canopy structure is clad with a back-lit polycarbonate panel system and is constructed with a low-slope standing seam metal roof,
3. Structure heating and ventilation consisting of infra-red electric heaters and low volume exhaust fans,
4. Site amenities including bicycle racks, benches and waste receptacles,
5. Landscaping improvements including a bio-swale, trellis panel wall, and site restoration in all disturbed areas.

1.3 USE OF PREMISES

A. For requirements see Exhibit E "General Construction Contract Conditions"

1.4 WORK RESTRICTIONS

A. For requirements see Exhibit E “General Construction Contract Conditions”

1.5 SUPPLEMENTAL SUBSTANTIAL COMPLETION REQUIREMENTS

A. At least seven (7) days prior to requesting a Substantial Completion inspection and in accordance with Exhibit E Section 26.7, the following items must be completed, along with any other items specified to be completed prior to Substantial Completion:

1. Equipment and Systems Startup - Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer. Verify that wiring and support components for equipment are complete and tested. Execute startup under supervision of manufacturer's representative or Contractors' personnel according to Contract requirements and manufacturer's instructions. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.
2. Provide and receive approval of Testing, Adjusting, and Balancing Reports as specified in individual Specification Sections.
3. Schedule the Demonstration and Training of Pace's personnel to occur prior to or concurrent with the requested Substantial Completion inspection. Required instruction time, sessions, location, content and other requirements as specified in individual Specification Sections.
4. Schedule the first session of Demonstration and Training of the HVAC system controls and/or Building Automation System (BAS), for projects that include this work, to occur prior to or concurrent with the request Substantial Completion inspection. Training must confirm that all controls devices, sequences and all specified monitoring points are working as intended and all user interface features, such as integration into Pace's network, BAS login permissions, alarm set points and notification messaging, occupancy scheduling, trend logging, etc., have all been programmed and available for initial setup to be completed during the first training session.
5. All Door Hardware, Surveillance, Security, Access Control, Fire Alarm, BAS, Communications and Data Systems must be completely installed, certified as specified, and operating properly, including all appropriate Pace staff fully trained in their operation.
6. Provide a list of keys, spare parts in a format acceptable to Pace, maintenance and extra products in quantities specified in individual Specification Sections. Lists must be on Pace's form, or another format acceptable to Pace, and include dates with supporting Pace signed transmittals indicating when and where

material was delivered and who at Pace received the extra material. Deliver to Pace prior to or concurrent with requested Substantial Completion inspection.”

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION (not used)

END OF SECTION 01100

INTENTIONALLY LEFT BLANK

SECTION 02100- SITE AMENITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bicycle racks
 - 2. Benches
 - 3. Waste Containers
- B. The work shall consist of furnishing and installing all materials, equipment and labor necessary for the placement and installation of bicycle racks, benches, and waste containers.

1.2 REFERENCES

- A. Reference Standards:
 - 1. AAMA 2603 - Pigmented Organic Coatings on Aluminum Extrusions and Panels.
 - 2. ASTM A36 - Carbon Structural Steel.
 - 3. ASTM A53 - Pipe, Steel, grey and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 4. ASTM A959 - Harmonized Standard Grade Compositions for Wrought Stainless Steels.

1.3 SUBMITTALS

- A. Manufacturer's Product Data.
- B. Manufacturer's Shop Drawings
- C. Color Samples for powder coat finish
- D. Manufacturer's Maintenance Instructions for field touch-up of finishes, cleaning, and maintenance.
- E. Warranty Documentation: Submit sample of manufacturer's warranty.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Tools: Tools provided or recommended by anti-tamper fastener manufacturer for operating antitamper fasteners (not provided by manufacturer)
 - 1. Type: Bit for drill or power screwdriver and hand driver with handle.
 - 2. Quantity: 2 of each
 - 3. Delivery: Submit tools directly to Pace.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect site amenities and accessories during delivery, storage, and handling to comply with manufacturer's instructions and prevent damage.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's warranty, agreeing to repair, replace, or refund the purchase price of products found defective, within the following time periods, commencing at product installation.

1. Material and workmanship: Five-year metal components warranty.
2. Limited twenty-year warranty against structural failure of all steel bench frames or complete steel bench assemblies and litter receptacle frames
3. Limited three-year warranty on structural failure of all bike racks.

PART 2 - PRODUCTS

2.1 Site Amenities

A. Bicycle Racks:

1. Manufacturers: DuMor Inc., SCH Enterprises, or equal
2. Basis of Design: DuMor Inc., Model 292 or SCH Enterprises HS 2
3. Size: Approximately 32 inches high by 40 inches wide.
4. Design: Single Horse Shoe radius.
5. Material: 2" Schedule 40 steel tubing with 3/8" steel base plates
6. Installation: Surface flange mounted in accordance with Manufacturer's recommendations using tamper and rust resistant fasteners.
7. Finish: Hot Dipped Galvanized.

B. Benches:

1. Manufacturers: DuMor Inc., SCH Enterprises, or equal
2. Basis of Design: DuMor Inc., Model 425 or SCH Enterprises Model RMBLB-RB
3. Size: 3 seats wide
4. Design: Three individual modular backless round metal bar fabricated seat assemblies with four intermediate metal bar armrests supported on a single metal pipe support with two metal bar legs. .
5. Metal: ASTM 36 Carbon steel
6. Finish: Minimum 4 mill zinc rich epoxy with minimum 4 mill polyester powder coating in accordance with ASTM coating standards.
7. Installation: Surface flange mounted in accordance with Manufacturer's recommendations using tamper and rust resistant fasteners.
8. Color: Manufacturer's Standard Grey.

C. Waste Container:

1. Manufacturers: DuMor Inc., SCH Enterprises, or equal
2. Basis of Design: DuMor Inc., Model 170BT or equal
3. Size: 32 Gal.
4. Design: Steel pipe base and top rings with perforated steel sheet nontapered barrel and hinged bonnet style domed spun steel cover and 32 gallon liner
5. Material: 16 gauge perforated metal sheet, 1" diameter schedule 40 steel pipe top & bottom ring frame and 14 gauge spun metal cover.
6. Installation: Surface flange mounted in accordance with Manufacturer's recommendations using tamper and rust resistant fasteners.
7. Color: Manufacturer's Standard Grey.

2.2 MATERIALS

A. Steel:

1. Pipe: ASTM A53, Type F or Type S, Grade A.
2. Plate, Shapes and Bars: ASTM A36.
3. Galvanized Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils.

Comply with coating manufacturer's written instructions.

2.3 FABRICATION

- A. Fabricate units with welded connections.
- B. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- C. Provide inserts and other anchorage devices for connecting amenities to substrate.
- D. Protect finishes from damage before shipping.
- E. Provide exposed fasteners and accessories with stainless materials, unless otherwise specified.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine paving or other substrates for compliance with manufacturer's requirements for placement and location of embedded items, condition of substrate, and other conditions affecting installation of site amenities.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with manufacturer's installation requirements and setting drawings.
- B. Install according to manufacturer's written instructions for specified setting method.
- C. Damaged, cracked, chipped, deformed or marred site amenities are not acceptable. Field touch-up minor imperfections in accordance with manufacturer's instructions.

3.3 CLEANING

- A. Immediately prior to Substantial Completion, clean site amenities in accordance with manufacturer's instructions to remove dust, dirt, adhesives, and other foreign materials.

3.4 PROTECTION

- A. Protect site amenities against damage.

END OF SECTION 02100

INTENTIONALLY LEFT BLANK

SECTION 02315 – EXCAVATION AND FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Earth Excavation, Special
- B. The Contractor may assume all soil excavated from the site is suitable for disposal at an Illinois Environmental Protection Agency (IEPA) permitted CCDD facility. If the Contractor is planning on disposing of uncontaminated soils at an Illinois Environmental Protection Agency (IEPA) permitted CCDD facility, the work shall be conducted in accordance with the criteria set forth in 35 Illinois Administrative Code (IAC) 1100. The following protocol must be followed:
 1. The Contractor must identify in writing the name and location of the Contractor's intended CCDD facility to Pace prior to the commencement of any construction activities.
 2. The Contractor is responsible for contacting the CCDD facility to identify the laboratory testing or certifications required for disposal acceptance.
 3. The Contractor will be responsible for a sampling / testing of the soil and preparation of the required certification form.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 INSTALLATION, Earth Excavation, Special

- A. This work shall consist of the removal of all existing materials located within the project limits, except rock and concrete items, unless specifically called out by specific work item, earth excavation and borrow excavation, the placement of all suitable excavated materials in the subgrade, or embankment, or as replacement unless specifically called out by separate work item. This work shall be specified and in accordance with Sections 202, 204, 205 and 440 of the Illinois Department of Transportation Standard Specifications with the exception of Sections 202.08, 204.08 and 440.08.

END OF SECTION 02315

INTENTIONALLY LEFT BLANK

SECTION 02370 – EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Perimeter Erosion Barrier
2. Inlet Filters

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Perimeter Erosion Barrier: Perimeter Erosion Barrier materials shall be according to Section 280.02 of the Illinois Department of Transportation Standard Specifications.
- B. Inlet Filters: Inlet Filter materials shall be according to Section 280.02 of the Illinois Department of Transportation Standard Specifications.
- C. Inspection and Maintenance: Inspection of erosion and sedimentation control fixtures shall be performed by the Contractor weekly. If at any point the Pace Representative feels that these fixtures require cleaning or replacement after initial installation, the Contractor shall perform said cleaning or replacement within three working days at no additional cost to the contract.

PART 3 - EXECUTION

3.1 INSTALLATION, Perimeter Erosion Barrier

- A. Execution of this item of work shall be according to Section 280 of the Illinois Department of Transportation Standard Specifications with the exception of Section 280.08.

3.2 INSTALLATION, Inlet Filters

- A. Execution of this item of work shall be according to Section 280 of the Illinois Department of Transportation Standard Specifications with the exception of Section 280.08.

END OF SECTION 02370

INTENTIONALLY LEFT BLANK

SECTION 02725 – AGGREGATE BASE COURSE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Aggregate Base Course, Type B

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Aggregate Base Course, Type B: Aggregate Base Course materials shall be according to Section 351.02 of the Illinois Department of Transportation Standard Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION, Aggregate Base Course, Type B (of depth specified)

- A. Execution of this item of work shall be according to Section 351 of the Illinois Department of Transportation Standard Specifications with the exception of Section 351.12.

END OF SECTION 02725

INTENTIONALLY LEFT BLANK

SECTION 02775 - SIDEWALKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Portland Cement Concrete Sidewalk
2. Protective Coat
3. Sidewalk Removal
4. Portland Cement Concrete Driveway Pavement

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Portland Cement Concrete Sidewalk: Portland Cement Concrete Sidewalk materials shall be according to Section 424.02 of the Illinois Department of Transportation Standard Specifications.
- B. Protective Coat: Protective Coat materials shall be according to Sections 420.02, 483.02 and 606.02 of the Illinois Department of Transportation Standard Specifications.
- C. Portland Cement Concrete Driveway Pavement: Driveway pavement materials shall be according to Sections 423.02 of the Standard Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION, Portland Cement Concrete Sidewalk (of thickness specified)

- A. Execution of this item of work shall be according to Section 424 of the Illinois Department of Transportation Standard Specifications with the exception of Section 424.13.
- B. In the event a sidewalk crosses adjacent driveway pavement, the Contractor shall pour the sidewalk to the same thickness as the proposed driveway asphalt layer.

3.2 INSTALLATION, Protective Coat

- A. Execution of this item of work shall be according to Sections 420 and 606 of the Illinois Department of Transportation Standard Specifications with the exception of Section 420.20.

3.3 INSTALLATION, Sidewalk Removal

- A. Execution of this item of work shall be according to Section 440 of the Illinois Department of Transportation Standard Specifications with the exception of Section 440.08.

3.4 INSTALLATION, Portland Cement Concrete Driveway Pavement (of thickness specified)

- A. Execution of this item of work shall be according to Section 423 of the Illinois Department of Transportation Standard Specifications with the exception of Section 423.11.

END OF SECTION 02775

SECTION 02830 CHAIN LINK FENCE (TEMPORARY)

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of temporary chain link fence panel installation is indicated on the Drawings.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data, and installation instructions for chain link fencing, fabric, gates and accessories.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Academy Fence Company, or equal.

2.2 GENERAL

- A. Fence Panel System:
 - a. Portable, 6' high x 12' wide, self-standing temporary chain link fence panels with 1-1/4" hot dipped galvanized steel pipe.
 - b. Fencing: 2" wire mesh; 11 GA with wire ties at every 18".
 - c. 1 peg stabilizer of hot-dipped galvanized steel pipe at ends.
 - d. 2 peg stabilizer of hot-dipped galvanized steel pipe to adjoin 2 panels in continuous line.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine area of construction of existing conditions and required area for an adequate enclosure for clearances required for construction, site access, staging, mobile office trailer, clearances for bus traffic at existing drive, and any other conditions affecting the area of enclosure required to maintain a safe and secure staging area during construction. Proceed with installation only after unsatisfactory conditions have been resolved.

3.2 INSTALLATION

- A. Install temporary fencing as indicated in this section and in the Drawings.
- B. Maintain clearance of adjacent drive during construction.

- C. Use the existing chain link fence to the south of the staging area as the south line of the staging enclosure.

3.3 CLEANING AND PROTECTION

- A. Protect the existing chain link fence to the south of the staging area during construction. Clean any surfaces from construction dirt. Repair or replace any fencing damaged during construction.

END OF SECTION 02830

SECTION 02920 – LAWNS AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Sodding, Salt Tolerant

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Topsoil, Furnish and Place, 4": Topsoil materials shall be according to Section 211.02 of the Illinois Department of Transportation Standard Specifications.
- B. Sodding, Salt Tolerant: Sodding materials shall be according to Section 252.02 of the Illinois Department of Transportation Standard Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION, Sodding, Salt Tolerant

- A. Execution of this item of work shall be according to Section 252 of the Illinois Department of Transportation Standard Specifications with the exception of Section 252.13.

3.2 INSTALLATION, Topsoil, Furnish and Place, 4"

- B. Execution of this item of work shall be according to Section 211 of the Illinois Department of Transportation Standard Specifications with the exception of Section 211.08.

END OF SECTION 02920

INTENTIONALLY LEFT BLANK

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mix water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- D. Welding Certificates: Copies of certificates for welding procedures and personnel.
- E. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
- F. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
 - 1. Cementitious materials and aggregates.
 - 2. Form materials and form-release agents.
 - 3. Steel reinforcement and reinforcement accessories.
 - 4. Admixtures.

5. Waterstops.
6. Curing materials.
7. Floor and slab treatments.
8. Bonding agents.
9. Adhesives.
10. Vapor retarders.
11. Epoxy joint filler.
12. Joint-filler strips.
13. Repair materials.

G. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.
- C. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
- D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- F. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- G. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
1. ACI 301, "Specification for Structural Concrete."
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- H. Preinstallation Conference: Conduct conference at Project site.
1. Before submitting design mixes, review concrete mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

- a. Contractor's superintendent.
- b. Independent testing agency responsible for concrete design mixes.
- c. Ready-mix concrete producer.
- d. Concrete subcontractor.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 GENERAL FORM-FACING MATERIALS

- A. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 1. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of the exposed concrete surface.
 2. Furnish ties that, when removed, will leave holes not larger than 1 inch (25 mm) in diameter in concrete surface.
 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

2.3 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.

- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615/A 615M, Grade 60 (Grade 420). Cut bars true to length with ends square and free of burrs.

2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
- B. Normal-Weight Aggregate: ASTM C 33, uniformly graded.
- C. Water: Potable and complying with ASTM C 94.

2.5 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
- G. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following:

- a. Catexol 1000CL; Axim Concrete Technologies.
- b. MCI 2000 or MCI 2005; Cortec Corporation.
- c. DCI or DCI-S; W. R. Grace & Co., Construction Products Div.
- d. Rheocrete 222+; Master Builders, Inc.
- e. FerroGard-901; Sika Corporation.
- f. or equal

2.7 VAPOR RETARDERS

- A. Vapor Retarder: ASTM E 1745, Class C, of one of the following materials; or polyethylene sheet, ASTM D 4397, not less than 15 mils (0.25 mm) thick:
 1. Stego Wrap, plastic wrap material; 15 mils (0.25 mm) thick.
 2. or equal.

- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch (38-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- F. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following:
 - 1. Evaporation Retarder:
 - a. Cimfilm; Axim Concrete Technologies.
 - b. Finishing Aid Concentrate; Burke Group, LLC (The).
 - c. Spray-Film; ChemMasters.
 - d. Aquafilm; Conspec Marketing & Manufacturing Co., Inc.
 - e. Sure Film; Dayton Superior Corporation.
 - f. Eucobar; Euclid Chemical Co.
 - g. Vapor Aid; Kaufman Products, Inc.
 - h. Lambco Skin; Lambert Corporation.
 - i. E-Con; L&M Construction Chemicals, Inc.
 - j. Confilm; Master Builders, Inc.
 - k. Waterhold; Metalcrete Industries.
 - l. Rich Film; Richmond Screw Anchor Co.
 - m. SikaFilm; Sika Corporation.
 - n. Finishing Aid; Symons Corporation.
 - o. Certi-Vex EnvioAssist; Vexcon Chemicals, Inc.
 - p. Or equal
 - 2. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound:
 - a. Klear-Kote Cure-Sealer-Hardener, 30 percent solids; Burke Group, LLC (The).
 - b. Polyseal WB; ChemMasters.
 - c. UV Safe Seal; Lambert Corporation.
 - d. Lumiseal WB Plus; L&M Construction Chemicals, Inc.
 - e. Vocomp-30; W. R. Meadows, Inc.
 - f. Metcure 30; Metalcrete Industries.
 - g. Vexcon Starseal 1315; Vexcon Chemicals, Inc.
 - h. Or equal

2.9 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.
- B. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
 - 1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
 - 2. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
 - 3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Reglets: Fabricate reglets of not less than 0.0217-inch- (0.55-mm-) thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- F. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.10 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Topping: Traffic-bearing, cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6 mm).
 - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3 to 6 mm) or coarse sand as recommended by topping manufacturer.

4. Compressive Strength: Not less than 5700 psi (39 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
 1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- C. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:
 1. Compressive Strength (28 Days): 3000 psi (20.7 MPa).
 2. Maximum Slump: 4 inches (100 mm).
 3. Maximum Slump for concrete Containing High-Range Water-Reducing Admixture: 8 inches (200 mm) after admixture is added to concrete with 2- to 4-inch (50- to 100-mm) slump.
- D. Slab-on-Grade: Proportion normal-weight concrete mix as follows:
 1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 2. Minimum Cementitious Materials Content: 520 lb/cu. yd. (309 kg/cu.m).
 3. Maximum Slump: 3 inches (75 mm).
- E. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 1. Fly Ash: 25 percent.
 2. Combined Fly Ash and Pozzolan: 25 percent.
 3. Ground Granulated Blast-Furnace Slag: 50 percent.
 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 5. Silica Fume: 10 percent.
 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent portland cement minimum, with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- F. Maximum Water-Cementitious Materials Ratio: 0.50 for concrete required to have low water permeability.
- G. Maximum Water-Cementitious Materials Ratio: 0.45 for concrete exposed to deicers or subject to freezing and thawing while moist.
- H. Maximum Water-Cementitious Materials Ratio: 0.40 for corrosion protection of steel reinforcement in concrete exposed to chlorides from deicing chemicals, salt, saltwater, brackish water, seawater, or spray from these sources.
- I. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 2 to 4 percent, unless otherwise indicated.

- J. Air Content: For concrete exposed to freezing. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated:
 - 1. Air Content: 5.5 percent for 1-1/2-inch- (38-mm-) nominal maximum aggregate size.
 - 2. Air Content: 6 percent for 1-inch- (25-mm-) nominal maximum aggregate size.
 - 3. Air Content: 6 percent for 3/4-inch- (19-mm-) nominal maximum aggregate size.
- K. Do not air entrain concrete to trowel-finished interior floors and suspended slabs. Do not allow entrapped air content to exceed 3 percent.
- L. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- M. Admixtures: Use admixtures according to manufacturers written instructions.
 - 1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
 - 2. Use corrosion-inhibiting admixture in concrete mixes where indicated.

2.12 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch (3 mm).
- D. Construct forms tight enough to prevent loss of concrete mortar.

- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
 - 1. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor bolts, accurately located, to elevations required.
 - 2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 3. Install dovetail anchor slots in concrete structures as indicated or required.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 VAPOR RETARDERS

- A. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.

3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Shop- or field-weld reinforcement according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Provide supports for WWF.

3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 - 3. Locate joints for slabs, in the middle third of spans.
 - 4. Locate horizontal joints in walls and columns at the top of footings or floor slabs.

5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch (12 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.
1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 WATERSTOPS

- A. Flexible Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's written instructions.
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into place. Install in longest lengths practicable.

3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

- B. Water may be added as long as it meets all ASTM requirements and all project specification requirements including but not limited to water-cement ratio.
- C. No water may be added at Project site.
- D. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- E. Deposit concrete in forms in horizontal layers no deeper than 24 inches (600 mm) and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
 - 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
 - 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- H. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to

control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch (3 mm) in height.
 1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.
 2. Do not apply rubbed finish to smooth-formed finish.
- C. Rubbed Finish: Apply the following to smooth-formed finished concrete:
 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.10 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes.
1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
 2. Finish and measure surface so gap at any point between concrete surface and an unveled freestanding 10-foot- (3.05-m-) long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
 - a. 1/8 inch (3.2 mm).
- E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Aggregate Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
1. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
 2. After broadcasting and tamping, apply float finish.
 3. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose slip-resistive aggregate.

3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

3.12 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 - 2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - 3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.13 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints where floors are exposed. Overfill joint and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.2-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch (19 mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Testing Agency: A/E, as agent of Owner, will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
 5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 6. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
 - a. Cast and field cure one set of four standard cylinder specimens for each composite sample.
 7. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.
 - a. Test two field-cured specimens at 7 days and two at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- D. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
- E. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect.
- H. In addition to requirements above, concrete shall be inspected per the requirements of IBC 2015 as follows:

**TABLE 1705.3
REQUIRED SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARD ^a	IBC REFERENCE
1. Inspect reinforcement, including prestressing tendons, and verify placement.	—	X	ACI 318 Ch. 20, 25.2, 25.3, 26.6.1-26.6.3	1908.4
2. Reinforcing bar welding: a. Verify weldability of reinforcing bars other than ASTM A706; b. Inspect single-pass fillet welds, maximum $\frac{3}{16}$ " and c. Inspect all other welds.	— X	X X	AWS D1.4 ACI 318: 26.6.4	—
3. Inspect anchors cast in concrete.	—	X	ACI 318: 17.8.2	—
4. Inspect anchors post-installed in hardened concrete members. ^b a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads. b. Mechanical anchors and adhesive anchors not defined in 4.a.	X	X	ACI 318: 17.8.2.4 ACI 318: 17.8.2	—
5. Verify use of required design mix.	—	X	ACI 318: Ch. 19, 26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X	—	ASTM C172 ASTM C91 ACI 318: 26.4, 26.12	1908.10
7. Inspect concrete and shotcrete placement for proper application techniques.	X	—	ACI 318: 26.5	1908.6, 1908.7, 1908.8
8. Verify maintenance of specified curing temperature and techniques.	—	X	ACI 318: 26.5.3-26.5.5	1908.9
9. Inspect prestressed concrete for: a. Application of prestressing forces; and b. Grouting of bonded prestressing tendons.	X X	— —	ACI 318: 26.10	—
10. Inspect erection of precast concrete members.	—	X	ACI 318: Ch. 26.8	—
11. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	—	X	ACI 318: 26.11.2	—
12. Inspect form work for shape, location and dimensions of the concrete member being formed.	—	X	ACI 318: 26.11.1.2(b)	—

For SI: 1 inch = 25.4 mm.

- a. Where applicable, see also Section 1705.12, Special Inspections for seismic resistance.
- b. Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.

1705.3.1 Welding of reinforcing bars.

Special inspections of welding and qualifications of special inspectors for reinforcing bars shall be in accordance with the requirements of AWS D1.4 for special inspection and of AWS D1.4 for special inspector qualification.

1705.3.2 Material tests.

In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapters 19 and 20 of ACI 318, the building official shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapters 19 and 20 of ACI 318.

END OF SECTION

INTENTIONALLY LEFT BLANK

SECTION 04200 – CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Face brick.
3. Mortar and grout.
4. Steel reinforcing bars.
5. Masonry joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.
9. Cavity-wall insulation.

1.2 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.
 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.4 PRECONSTRUCTION TESTING (Not Used)

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection:
 1. Face brick.
 2. Weep holes/vents.
 3. For units with factory-applied color red finishes.

1.6 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
 - 1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and Pace and approved in writing.
- B. Qualification Data: For testing agency.
- C. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence according to ASTM C 67.
 - d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing per ASTM C 67.
 - 2. Cementitious materials. Include brand, type, and name of manufacturer.
 - 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 4. Grout mixes. Include description of type and proportions of ingredients.
 - 5. Reinforcing bars.
 - 6. Joint reinforcement.
 - 7. Anchors, ties, and metal accessories.
- D. 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 C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
 - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
- F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
- C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
 - 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS

- A. Regional Materials: CMUs shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide square-edged units for outside corners unless otherwise indicated.
- C. CMUs: ASTM C 90.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi.
 2. Density Classification: Normal weight, unless otherwise indicated.
 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

4. Exposed Faces: Provide red CMU where indicated on Drawings.

2.3 BRICK

- A. Regional Materials: Brick shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
- C. Face Brick: Facing brick complying with ASTM C 216.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work.
 2. Grade: SW.
 3. Type: FBX or HBX
 4. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3350 psi.
 5. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
 6. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 7. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet or shall have a history of successful use in Project's area.
 8. Size (Actual): 3-5/8 inches wide by 2-1/4 inches high by 11-5/8 inches long.
 9. Application: Use where brick is exposed unless otherwise indicated.

2.4 MORTAR AND GROUT MATERIALS

- A. Regional Materials: Aggregate for mortar and grout, cement, and lime shall be extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Portland Cement: ASTM C 150, 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.
- C. Mortar Cement: ASTM C 1329.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lafarge North America Inc.; Lafarge Mortar Cement, or equal.
- D. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Euclid Chemical Company (The); Accelguard 80.
 - b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
 - c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.
- E. Water: Potable.

2.5 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
 1. Exterior Walls: Hot-dip galvanized, carbon steel.
 2. Wire Size for Side Rods: 0.187-inch diameter.
 3. Wire Size for Cross Rods: 0.187-inch diameter.
 4. Wire Size for Veneer Ties: 0.187-inch diameter.
 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- C. Masonry Joint Reinforcement for Multiwythe Masonry:
 1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches wide, plus 1 side rod at each wythe of masonry 4 inches wide or less.
 2. Tab type, either ladder or truss design, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.
- D. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch- diameter, hot-dip galvanized, carbon steel continuous wire.

2.6 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. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 641/A 641M, Class 1 coating.
 2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
 3. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.
 4. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
 5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units.
 2. Where wythes are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
 3. Wire: Fabricate from 3/16-inch- diameter, hot-dip galvanized steel wire.

2.7 MISCELLANEOUS ANCHORS

- A. Anchor Bolts: L-shaped steel bolts complying with ASTM A 307, Grade A with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.8 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing as follows:
1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
 2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
 3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
 - a. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Cheney Flashing Company;
 - 2) Keystone Flashing Company, Inc.; Keystone 3-Way Interlocking Thruwall Flashing.
 - 3) Sandell Manufacturing Co., Inc.; Mechanically Keyed Flashing.
4. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees.
 5. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
 6. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.
- B. Application: Unless otherwise indicated, use the following:
1. Where flashing is indicated to receive counter flashing, use metal flashing.
 2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
 3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge.
 4. Where flashing is fully concealed, use metal flashing.
- C. Solder and Sealants for Sheet Metal Flashings:
1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
 2. Elastomeric Sealant: ASTM C 920, chemically curing polysulfide sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Use the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from UV-resistant synthetic fiber, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity. Use only for weeps.
 2. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advanced Building Products Inc.; Mortar Break.
 - b. Archovations, Inc.; CavClear Masonry Mat.
 - c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
 - d. Mortar Net USA, Ltd.; Mortar Net.
 2. Provide one of the following configurations:
 - a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep that prevent clogging with mortar droppings.
 - b. Strips, not less than 3/4 inch thick and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.

2.10 CAVITY-WALL INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type X, closed-cell product extruded with an integral skin.
- B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.11 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 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. Diedrich Technologies, Inc.

- b. EaCo Chem, Inc.
- c. ProSoCo, Inc.

2.12 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 mortar unless otherwise indicated.
 - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. For reinforced masonry, use Type N.
 - 2. For mortar parge coats, use Type N.
 - 3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
- C. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C 476, Table 1.
 - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. 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.
- E. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or 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 in a story height or 1/2 inch total.
- 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 conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
 - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

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 exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 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 stack bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

- H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and CMUs as follows:
 - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 NOT USED

3.7 CAVITY WALLS

- A. Bond wythes of cavity walls together using bonding system indicated on Drawings.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
 - 1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.8 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
 - 1. Space reinforcement not more than 16 inches o.c.
 - 2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.9 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
- C. Form expansion joints in brick as follows:
 - 1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
 - 2. Build flanges of factory-fabricated, expansion-joint units into masonry.
 - 3. Build in compressible joint fillers where indicated.
 - 4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod.
- D. Provide horizontal, pressure-relieving joints by inserting a compressible filler of width required for installing sealant and backer rod, but not less than 3/8 inch.
 - 1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.10 LINTELS

- A. Install steel lintels where indicated.
- B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

- B. Install flashing as follows unless otherwise indicated:
1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and 1-1/2 inches into the inner wythe.
 3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.
 4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant
 6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
 7. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
 8. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- E. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
 2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes 24 inches o.c. unless otherwise indicated.
 4. Space weep holes formed from plastic tubing or wicking material 16 inches o.c.
 5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
 6. Trim wicking material flush with outside face of wall after mortar has set.
- F. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

- G. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.
 - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.12 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect and Pace's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 - 6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.13 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 04200

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes structural steel.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 1 Section "Quality Control" for independent testing agency procedures and administrative requirements.
 - 2. Division 5 Section "Metal Fabrications" for loose steel bearing plates and miscellaneous steel framing.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Engineer structural steel connections required by the Contract Documents to be selected or completed by the fabricator to withstand design loadings indicated.
- B. Engineering Responsibility: Engage a fabricator who utilizes a qualified Structural Engineer to prepare calculations, Shop Drawings, and other structural data for structural steel connections.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.
- C. Shop Drawings detailing fabrication of structural steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.
 4. Include shop drawings signed and sealed by a qualified professional engineer responsible for their preparation.
- D. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Mill test reports signed by manufacturers certifying that their products, including the following, comply with requirements.
1. Structural steel, including chemical and physical properties.
 2. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 3. Shop primers.
 4. Non-shrink grout.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.
- C. Comply with applicable provisions of the following specifications and documents:
1. AISC's "Specifications for Structural Steel Buildings – Allowable Stress Design and Plastic Design."
 2. AISC's "Specification for Allowable Stress Design of Single-Angle Members."
 3. AISC's "Seismic Provisions for Structural Steel Buildings."
 4. ASTM A 6 (ASTM A 6M) "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
 5. Research Council on Structural Connections (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Professional Engineer Qualifications: A registered structural engineer who is legally authorized to practice in the jurisdiction where the project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

- E. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel."
 - 1. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 SEQUENCING

- A. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Steel Shapes, Plates, and Bars: As follows:
 - 1. High-Strength, Low-Alloy Columbium-Vanadium Steel: ASTM A 992, Grade 50, for all wide flange shapes.
 - 2. Rolled Angles, Channels, Plates, and Bars to Comply with ASTM A36.
- B. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B.
- C. Anchor Rods, Bolts, Nuts, and Washers: As follows:
 - 1. Unheaded Rods: ASTM A 36 (ASTM A 36M).
 - 2. Headed Bolts: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts and heavy hex carbon-steel nuts.
 - 3. Washers: ASTM A 36 (ASTM A 36M).

- D. Nonhigh-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon-steel, hex-head bolts; carbon-steel nuts; and flat, unhardened steel washers.
 - 1. Finish: Plain, uncoated.
- E. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Plain, uncoated.
- F. Welding Electrodes: Comply with AWS requirements.

2.2 PRIMER

- A. Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer with good resistance to normal atmospheric corrosion, complying with performance requirements of FS TT-P-664.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time.

2.4 FABRICATION

- A. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.
 - 1. Camber structural steel members where indicated.
 - 2. Identify high-strength structural steel according to ASTM A 6 (ASTM A 6M) and maintain markings until steel has been erected.
 - 3. Mark and match-mark materials for field assembly.
 - 4. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.
 - 5. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
 - 6. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded.

- C. Finishing: Accurately mill ends of columns and other members transmitting loads in bearing.
- D. Shear connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturers printed instructions.
- E. Steel Wall Framing: Select true and straight members for fabricating steel wall framing to be attached to structural steel framing. Straighten as required to provide uniform, square, and true members in completed wall framing.
- F. Welded Door Frames: Build up welded door frames attached to structural steel framing. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10 inches (250 mm) o.c., unless otherwise indicated.
- G. Holes: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on Shop Drawings.
 - 1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.
 - 2. Weld threaded nuts to framing and other specialty items as indicated to receive other work.

2.5 SHOP CONNECTIONS

- A. Shop install and tighten non-high-strength bolts, except where high-strength bolts are indicated.
- B. Shop install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.
 - 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.
 - 2. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds 1/2 inch (13 mm) and larger. Grind flush butt welds. Dress exposed welds.

2.6 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 2. Surfaces to be field welded.
 3. Surfaces to receive sprayed-on fireproofing.
 4. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits. Prepare surfaces according to SSPC specifications.
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply 2 coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

2.7 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel indicated for galvanizing according to ASTM A 123.

2.8 SOURCE QUALITY CONTROL

- A. Owner may engage an independent testing and inspecting agency to perform shop inspections and tests and to prepare test reports.
1. Testing agency will conduct and interpret tests and state in each report whether test specimens comply with or deviate from requirements.
 2. Provide testing agency with access to places where structural steel Work is being fabricated or produced so required inspection and testing can be accomplished.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- D. Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
1. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.
- E. In addition to visual inspection, shop-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option. Minimum not less than 10% of welds will be tested.

1. Liquid Penetrant Inspection: ASTM E 165.
 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
 4. Ultrasonic Inspection: ASTM E 164.
- F. In addition to visual inspection, shop-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows: Not less than 10% of shear connectors will be tested.
1. Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector.
 2. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.
- B. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.
- B. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
 3. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
 - a. Comply with manufacturer's instructions for proprietary grout materials.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
1. Maintain erection tolerances of architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
 2. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection.
- H. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

- A. Install and tighten nonhigh-strength bolts, except where high-strength bolts are indicated.
- B. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

1. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.
3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds 1/2 inch (13 mm) and larger. Grind flush butt welds. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
 1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- D. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- E. Field-bolted connections will be tested and inspected according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 1. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.
- F. In addition to visual inspection, field-welded connections will be inspected and tested according to AWS D1.1 and the inspection procedures listed below, at testing agency's option. As least 10% of welds will be tested.
 1. Liquid Penetrant Inspection: ASTM E 165.
 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 3. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T."
 4. Ultrasonic Inspection: ASTM E 164.

- G. In addition to visual inspection, field-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows: At least 10% of shear connectors will be tested.
 - 1. Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.
- H. In addition to requirements above, steel shall be inspected per the requirements of IBC 2015 as follows:

1705.2 Steel construction.

The *special inspections* and nondestructive testing of steel construction in buildings, structures, and portions thereof shall be in accordance with this section.

Exception: *Special inspections* of the steel fabrication process shall not be required where the fabricator does not perform any welding, thermal cutting or heating operation of any kind as part of the fabrication process. In such cases, the fabricator shall be required to submit a detailed procedure for material control that demonstrates the fabricator's ability to maintain suitable records and procedures such that, at any time during the fabrication process, the material specification and grade for the main stress-carrying elements are capable of being determined. Mill test reports shall be identifiable to the main stress-carrying elements when required by the *approved construction documents*.

1705.2.1 Structural steel.

Special inspections and nondestructive testing of *structural steel elements* in buildings, structures and portions thereof shall be in accordance with the quality assurance inspection requirements of AISC 360.

Exception: *Special inspection* of railing systems composed of *structural steel elements* shall be limited to welding inspection of welds at the base of cantilevered rail posts.

3.6 CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils (0.038 mm).
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on structural steel are included in Division 9 Section "Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A 780.

END OF SECTION

SECTION 05192 - ENGINEERED LIGHT GAUGE METAL TRUSSES

1.1 RELATED DOCUMENTS

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

1.2 GENERAL

- A. Types of cold-formed metal framing units include the following:
Engineered light gauge metal trusses.
 - 1. Roof truss design based on schematic drawings provided by:

Progressive Panel Systems 8141 Logistic Drive, Suite A Zeeland, MI 49464 1-800-964-6783	Superior Truss & Panel, Inc. 2204 W., 159 th Street Markham, Illinois 60426 1-708-339-1200
--	--
- B. Structural Performance: Engineer, fabricate, and erect light gauge trusses to withstand design loads
- C. Engineering Responsibility: Engage a fabricator who uses a qualified structural engineer to prepare calculations, Shop Drawings, and other structural data for trusses.
- D. Submittals: In addition to Product Data and installation instructions, submit Shop Drawings detailing location, gauge, size, pitch, span, camber, configuration, bearing details, design values and spacing for each type of truss required.
 - 1. Include truss Shop Drawings and structural analysis data signed and sealed by the qualified structural engineer responsible for their preparation.
 - 2. Quality Assurance: Submit for information qualification data for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project name, addresses, names of Architects and Owners, and other information specified.
- E. Single-Source Engineering Responsibility: Provide trusses engineered by manufacturer to support superimposed dead and live loads indicated, with design approved and certified by a qualified structural engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in the design of light gauge trusses.
- F. Handle and store trusses with care and comply with manufacturer's written instructions to avoid damage and lateral bending
- G. Design and provide supplemental panel/chord members to support equipment or other loads that are created by other trades and shown on their respective drawings.

1.3 QUALITY ASSURANCE

- A. Component Design: Calculate structural properties of light gauge metal trusses in accordance with American Iron and Steel Institute (AISI) "Specification for Design of Cold-Formed Steel Structural Members."
- B. Qualifications:
 - 1. Contractor: Contractor is responsible for quality control of the Work.
 - 2. Manufacturer: A firm experienced in successfully producing work similar to that indicated for this Project, with a record of successful in-service performance, and with sufficient production capacity to produce required units without causing delay in the Work.
 - a. Experience: Minimum of 3 years.
 - 3. Installer: An installer trained by the manufacturer in the use of the materials and equipment to be employed in the Work.
 - a. Experience: Minimum of 3 years.
- C. Pre-Installation Conference: Prior to start of installation of metal framing systems, meet at project site with installers of other work including door and window frames and mechanical and electrical work. Review areas of potential interference and conflicts, and coordinate layout and support provisions for interfacing work.
- D. Coordinate with provisions of Division 1 section "Project Meetings."

1.4 METAL FRAMING

- A. System Components: Manufacturer's standard load-bearing steel members of type, size, shape, and gauge as indicated. With each type of metal framing required, provide manufacturer's standard steel chords, blocking, clip angles, shoes, reinforcements, purlins, fasteners, and accessories for applications indicated, as needed to provide a complete metal framing system.
- B. Materials and Finishes:
 - 1. For 18-gauge and lighter units, fabricate metal framing components of commercial quality steel sheet with a minimum yield point of 33,000 psi, ASTM A446, A570, or A611.
 - 2. For 16-gauge and heavier units, fabricate metal framing components of structural quality steel sheet with a minimum yield point of 50,000 psi; ASTM A570, B 955, and C 955 for minimum G 60 coating.
 - a. Finish of installation accessories to match that of main framing components, unless otherwise indicated.
 - 3. Fasteners: Provide nuts, bolt, washers, screws, and other fasteners with corrosion-resistant plated finish.

1.5 FABRICATION

- A. General: Framing components may be prefabricated into assemblies before erection. Fabricate panels plumb, square, true to line, and braced against racking with joints welded, bolted, or screw attached. Perform lifting of prefabricated units to prevent damage or distortion.

- B. Fabricate units in jig templates to hold members in proper alignment and position and to assure consistent component placement.
- C. Fastening: Attach similar components by welding or screw fasteners. Attach dissimilar components by welding, bolting, or screw fasteners, as standard manufacturer.
- D. Fabrication Tolerances: Fabricate units to a maximum allowable tolerance variation from plumb, level, true to line of 1/8 inch in 10 feet.
- E. Trusses must be shop fabricated.

1.6 EXECUTION

- A. Install bridging or bracing of trusses according to manufacturer's recommendations. Space trusses as indicated; install plumb, square, and true to line; and securely fasten to supporting construction.
- B. Anchor trusses securely at all bearing points using metal framing anchors and fasten according to metal framing anchor manufacturer's fastening schedules and written instructions.
- C. Securely connect each truss ply required for forming built-up girder trusses. Anchor trusses to girder trusses as indicated.
- D. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
- E. Do not alter, cut, or remove truss members.
- F. Return light gauge trusses that are damaged or do not meet requirements to fabricator and replace with trusses that do meet requirements.
- G. Provide web stiffeners at reaction points as required by truss design.
- H. Provide truss bridging or bracing as required by truss design.
- I. Field Painting: Touch-up damaged shop-applied protective coatings. Use compatible primer for prime-coated surfaces

END OF SECTION

INTENTIONALLY LEFT BLANK

SECTION 05310 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Roof deck.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for concrete fill and reinforcing steel.
 - 2. Division 5 Section "Structural Steel" for shop-welded shear connectors.

1.3 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.
- C. Product Certificates: Signed by steel deck manufacturers certifying that products furnished comply with requirements.
- D. Welding Certificates: Copies of certificates for welding procedures and personnel.
- E. Product Test Reports: From a qualified testing agency indicating that each of the following complies with requirements, based on comprehensive testing of current products:
 - 1. Mechanical fasteners.
- F. Research/Evaluation Reports: Evidence of steel deck's compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
- D. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- E. FM Listing: Provide steel roof deck evaluated by FM and listed in FM's "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.5 DELIVERY, STORAGE, AND HANDLING

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

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Deck:
 - a. BHP Steel Building Products USA Inc.
 - b. Consolidated Systems, Inc.
 - c. Epic Metals Corp.
 - d. Marlyn Steel Products, Inc.
 - e. Nucor Corp.; Vulcraft Div.
 - f. Roof Deck, Inc.
 - g. United Steel Deck, Inc.

- h. Verco Manufacturing Co.
- i. Wheeling Corrugating Co.; Div. of Wheeling-Pittsburgh Steel Corp.
- j. or equal.

2.2 ROOF DECK

- A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 29, and the following:
 - 1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180)zinc coating.
 - 2. Deck Profile: As indicated.
 - 3. Profile Depth: As indicated.
 - 4. Design Uncoated-Steel Thickness: As indicated.
 - 5. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: 0.0474/0.0474 inch (1.20/1.20 mm).
 - 6. Span Condition: As indicated.
 - 7. Side Laps: Overlapped.

2.3 ACCESSORIES

- A. General: 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 (4.8 mm) 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 (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Steel Sheet Accessories: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- G. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 29 for overhang and slab depth.
- H. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

- I. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- J. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) inch (1.90 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
- K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and level sloped recessed pans of 1-1/2- inch (38-mm) minimum depth. For drains, cut holes in the field.
- L. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.
- M. Galvanizing Repair Paint: ASTM A 780 SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.
- N. Repair Paint: Lead- and chromate-free rust-inhibitive primer complying with performance requirements of FS TT-P-664.

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.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 29, 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 decking 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 for entire 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 decking.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, 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, unless otherwise noted, may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF DECK INSTALLATION

- A. Fasten roof deck panels to steel supporting members with tek screws as indicated on drawings, or by arc spot (puddle) welds of the surface diameter indicated on drawings, or arc seam welds with an equal perimeter, but not less than 2.0 inches (38 mm) long, and as follows:
 - 1. Weld Diameter: 5/8inch (16 mm), nominal.
 - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of four welds per deck unit at each support. Space welds at 8 or 12 inches (as indicated) (305 mm) apart in the field of the roof and 6 inches (150 mm) apart in roof corners and perimeter, based on roof-area definitions of FM Loss Prevention Data Sheet 1-28 as indicated.
 - 3. Weld Washers: Install weld washers at each weld location as required by deck manufacturer.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals as follows and as indicated on plans.
 - 1. Mechanically fasten with self-drilling No. 10 (4.8-mm-) diameter or larger carbon-steel screws.
 - 2. Fasten with a minimum of 5/8 inch diameter.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
 - 1. End Joints: Lapped 2 inches (51 mm) minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof decking and weld flanges to top of deck. Space welds not more than 12 inches (305 mm) apart with at least 1 weld at each corner.
- E. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.
- G. Sound-Absorbing Insulation: Installation into topside ribs of deck as specified in Division 7 Section .

3.4 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing agency to perform field quality-control testing.
- B. Field welds will be subject to inspection.
- D. Testing agency will report test results promptly and in writing to Contractor and Architect.
- E. Remove and replace work that does not comply with specified requirements.
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
 - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
 - 2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Division 9 Section .
- D. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 05400 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing.
2. Ceiling joist framing.
3. Soffit framing.

1.2 PREINSTALLATION MEETINGS

- ##### A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- ##### A. Product Data: For each type of cold-formed steel framing product and accessory.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

- ##### C. Delegated-Design Submittal: For cold-formed steel framing.

1.4 INFORMATIONAL SUBMITTALS

- ##### A. Welding certificates.

- ##### B. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Mechanical fasteners.
4. Miscellaneous structural clips and accessories.

- ##### C. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. AllSteel & Gypsum Products, Inc.
2. ClarkWestern Building Systems, Inc.
3. Craco Mfg., Inc.
4. Custom Stud Inc.
5. Design Shapes in Steel.
6. Formetal Co. Inc. (The).
7. MarinoWARE.
8. Nuconsteel; a Nucor Company.
9. Olmar Supply, Inc.
10. Quail Run Building Materials, Inc.
11. SCAFCO Corporation.
12. State Building Products, Inc.
13. Steel Construction Systems.
14. Steeler, Inc.
15. Super Stud Building Products, Inc.
16. Telling Industries, LLC.
17. United Metal Products, Inc.
18. or equal.

2.2 PERFORMANCE REQUIREMENTS

- A. Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated in Drawings and Specifications.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Ceiling Joist Framing: Vertical deflection of 1/240 of the span for live loads and 1/240 for total loads of the span.
3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or

other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 1/2 inch.
5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

B. Cold-Formed Steel Framing Design Standards:

1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Lateral Design: AISI S213.

C. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

D. Fire-Resistance Ratings: Comply with ASTM E 119; 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 the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.
2. Coating: A60 or equivalent.

B. Steel Sheet for Vertical Deflection and Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance.
2. Coating: G60 (Z180) or equivalent.

2.4 CEILING JOIST FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with standard holes with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 1.09 mm.
2. Flange Width: 2 inches, minimum.

2.5 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. Anchor clips.
 - 5. End clips.
 - 6. Foundation clips.
 - 7. Stud kickers and knee braces.
 - 8. Joist hangers and end closures.
 - 9. Hole reinforcing plates.
 - 10. Backer plates.

2.6 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.
- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
- E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780.
- B. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.
- C. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.8 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural framing 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 PREPARATION

- A. Install load bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
- B. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 07210 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.
- J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05400

INTENTIONALLY LEFT BLANK

SECTION 06160 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
 - 2. Roof sheathing.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS

- A. Certified Wood: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship":
 - 1. Plywood.
- B. Plywood: Either DOC PS 1 or DOC PS 2 unless otherwise indicated.

- C. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- D. Factory mark panels to indicate compliance with applicable standard.

2.2 ROOF SHEATHING

- A. Plywood Roof Sheathing: Exterior sheathing includes vertical roof opening and fascia.
 - 1. Span Rating: Not less than 20/0.
 - 2. Nominal Thickness: Not less than 3/4 inch.

2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For roof sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.
 - 1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C 1002.
 - 2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
- D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 - 1. Wall and Roof Sheathing:
 - a. Screw to cold-formed metal framing.
 - b. Space panels 1/8 inch apart at edges and ends.

END OF SECTION 06160

INTENTIONALLY LEFT BLANK

SECTION 07210 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Foam-plastic board insulation.
 - 2. Vapor retarders.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
 - 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. DiversiFoam Products.
 - b. Dow Chemical Company (The).
 - c. Owens Corning.
 - d. Pactiv Building Products.
 - e. or equal.
 - 2. Type IV, 25 psi.

2.2 VAPOR RETARDERS

- A. Felt Vapor Retarders: #30 Felt – ASTM D4869, Type IV, ASTM D226, Type II.
- B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.
- D. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.
- E. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

2.3 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.

- b. Gemco; Spindle Type.
 - c. or equal.
 - 2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.
- B. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch between face of insulation and substrate to which anchor is attached.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Gemco; Clutch Clip.
 - b. or equal
- C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGM Industries, Inc.; TACTOO Adhesive.
 - b. Gemco; Tuff Bond Hanger Adhesive.
 - c. or equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

- A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of 36 inches below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

3.4 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.
 - 1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 04200 "Concrete Unit Masonry."

3.5 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

- A. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
 - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
 - 2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
 - 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.

4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.6 INSTALLATION OF VAPOR RETARDERS

- A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.
 1. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches o.c.
 2. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
 3. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
- C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.
- D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.7 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07210

INTENTIONALLY LEFT BLANK

SECTION 07271 - SELF-ADHESIVE AIR/ VAPOR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section Includes the following:
 - 1. Surface preparation.
 - 2. Application of rolled, self-adhering air/ vapor barrier system.
 - 3. Application of materials to provide bridge and seal air leakage pathways in:
 - a. Wall and roof connections and penetrations
 - b. Connections to foundation walls
 - c. Walls, windows, curtain walls, storefronts, louvers, or doors
 - d. Expansion and control joints
 - e. Masonry ties
 - f. All other penetrations through the wall assembly

1.2 REFERENCES

- A. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
- B. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
- C. ASTM D882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
- D. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
- E. ASTM E96 (Method B) - Standard Test Methods for Water Vapor Transmission of Materials.

1.3 ACTION SUBMITTALS

- A. Submit manufacturer's product data and application instruction.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Store materials in a clean, dry area in accordance with manufacturer's instructions.
- C. Store adhesives and primers at temperatures of 40° F (5° C) and above to facilitate handling.
- D. Store membrane cartons on pallets.

- E. Do not store at temperatures above 90° F (32° C) for extended periods.
- F. Keep away from sparks and flames.
- G. Completely cover when stored outside. Protect from rain.
- H. Protect materials during handling and application to prevent damage or contamination.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Product not intended for uses subject to abuse or permanent exposure to the elements.
- B. Protect rolls from direct sunlight until ready for use
- C. Do not apply membrane when air or surface temperatures are below 40° F (4° C).
- D. Do not apply to frozen surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. W. R. Meadows, Inc.
 - 2. Polyguard Products, Inc.
 - 3. Protecto Wrap Company.
 - 4. or equal.

2.2 MATERIALS

- A. Rolled, Self-Adhering Air/Vapor Barrier Membrane: Polymeric air/vapor barrier membrane protected by release paper on cross-laminated polyethylene carrier film with exposed polymeric membrane strips on both sides protected by pull-off release strips.
- B. Performance Based Specification: Membrane shall have the following characteristics:
 - 1. Air Leakage, ASTM E2357: ≤ 0.04 cfm / ft.² @ 75 Pa (1.57 lb./ft.²).
 - 2. Air Permeability, ASTM E2178: ≤ 0.004 cfm / ft.² @ 75 Pa (1.57 lb./ft.²).
 - 3. Water Vapor Permeance, ASTM E96 (Method B): ≤ 0.035 perms.
 - 4. Elongation, ASTM D412: 400 %.
 - 5. Tensile Strength, ASTM D412: 4000 psi (27.6 MPa).
 - 6. Lap Peel Strength @ 39° F (3.9° C), ASTM D903, 180 Bend: 10 lbf/in.

2.3 ACCESSORIES

- A. Flashing and Transition Membrane: Self-adhesive polymeric sheet membrane having a thickness of 40 mils.
- B. Liquid Flashing: Fluid applied, single component, flashing membrane for rough openings and detailing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive membrane. Notify Architect and Pace if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Protect adjacent surfaces not designated to receive air/vapor barrier system.
- B. All surfaces must be clean, smooth, and dry and must be clean of oil, dust, and excess mortar in accordance with manufacturer's instructions.
- C. Do not apply air/vapor barrier to surfaces unacceptable to manufacturer.
- D. Strike masonry joints flush.
- E. Patch all holes and voids and smooth out any surface misalignments.
- F. Concrete surfaces must be cured for a minimum of 14 days.
- G. If curing compounds are used, they must be clear, resin based, without oil, wax, or pigments.

3.3 APPLICATION OF AIR BARRIER SYSTEM

- A. TRANSITION MEMBRANE
 1. Prime the area to be detailed using adhesive recommended by the membrane manufacturer according to the substrate.
 2. Apply transition membrane with a minimum overlap of 3" (75 mm) onto primed surface at all joints, columns, and beams as indicated in drawings.
 3. Tie in to door openings, roofing systems, floor intersections, and dissimilar materials.
 4. Roll membrane firmly into place.
 5. Ensure membrane is fully adhered and remove all wrinkles and fish mouths.
 6. Overlap subsequent courses of membrane a min. of 2" and ensure joints are fully adhered.
 7. Seal top edge of transition membrane with pointing mastic.

3.4 THROUGH WALL FLASHING

- A. Prime the area to be detailed using adhesive recommended by the membrane manufacturer according to the substrate.
- B. Remove release paper prior to application.
- C. Apply through wall flashing at based of masonry walls as indicated on drawings.
- D. Recess through wall flashing 1/2" from the face of the masonry.
- E. Apply a bead of pointing mastic if through wall flashing is not embedded into masonry.

3.5 AIR BARRIER MEMBRANE

- A. Apply air barrier membrane system in accordance with manufacturer's instructions.
- B. Ensure accessory materials are compatible with membrane and approved by membrane manufacturer.
- C. Prime the area to be detailed using adhesive recommended by the membrane manufacturer according to the substrate. Re-apply adhesive to uncovered surfaces next day.
- D. Apply membrane to primed surface by removing release paper and rolling membrane firmly into place.
- E. Ensure membrane is fully adhered and remove all wrinkles and/or fish mouths.
- F. Cut air barrier membrane to detail around protrusions and masonry reinforcing.
- G. Overlap subsequent courses of membrane a minimum of 2" in a shingle fashion.
- H. Inspect membrane before covering and repair as necessary. Cover tears and inadequate overlaps with membrane. Seal edges of patches with pointing mastic.
- I. Seal all end laps and protrusions with pointing mastic.
- J. Avoid use of products which contain tars, solvents, pitches, polysulfide polymers, or PVC materials that may come into contact with waterproofing membrane system.

3.04 PROTECTION

- A. Cover air barrier membrane as soon as possible, since it is not designed for permanent exposure.

END OF SECTION 07271

SECTION 07411 METAL ROOF PANELS

PART 1 GENERAL

1.1 SUMMARY

A. SECTION INCLUDES

1. Standing-seam metal roof panels, including trim and accessories

2. RELATED SECTIONS

- a) Section 05310 - Steel Decking
- b) Section 07920 - Joint Sealants

1.2 REFERENCES

- A. AISI S-100 – North American Specification for the Design of Cold-Formed Steel Structural Members
- B. ASCE-7: American Society of Civil Engineers -Minimum Design Loads for Buildings and Other Structures; version adopted by local Building Code authority having jurisdiction.
- C. ASTM B209 - Specification for Aluminum-Alloy Sheet and Plate
- D. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Sidim by Uniform Static Air Pressure Difference
- E. UL 580 - Tests for Uplift Resistance of Roof Assemblies

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Sheet metal roofing system including, but not limited to, metal roof panels, cleats, clips, anchors and fasteners, sheet metal flashing integral with sheet metal roofing, fascia panels, trim, underlayment, and accessories shall comply with requirements indicated without failure due to defective manufacture, fabrication, installation, or other defects in construction. Sheet metal roofing shall remain watertight.
- B. Thermal Movements: Provide sheet metal roofing that allows for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient, material surfaces.
- C. Solar Reflectance Index: Not less than 29 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meetings:

1. Schedule meeting to discuss roof project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements before start of work onsite.
2. Required attendees: Contractor, metal deck & roof installer, and any other subcontractors who have equipment penetrating the roof or Work that requires roof access or traffic.

1.5 SUBMITTALS

A. Product Data: Manufacturer literature indicating product specifications, installation instructions, and standard construction details for specified products.

B. Shop Drawings: Show fabrication and installation layouts of metal roofing PANELS, including plans, elevations, expansion joint locations, and keyed details.

1. Distinguish between shop- and field-assembled work. Include the following:

- a) Details for forming metal roofing panels, including seams and dimensions.
- b) Details for joining and securing metal roofing panels, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
- c) Details of termination points and assemblies, including fixed points.
- d) Details of expansion joints, including showing direction of expansion and contraction.
- e) Details of roof penetrations.
- f) Details of edge conditions, including eaves, rakes, soffit, and counter flashings.
- g) Details of special conditions.
- h) Details of connections to adjoining work.
- i) Detail of the flashing and trim at a scale of not less than 3 inches per 12 inches:
- j) Include details of each condition of installation, including the locations and types of fasteners, sealants and accessories. Indicate locations, gauges, shapes, and methods of attachment of all panels, accessories and trim.

2. Roof Panel Attachment:

- a) Roof plan with wind uplift pressure calculations at field, corner and perimeter areas according to version of ASCE-7 referenced by locally-adopted Building Code and the authority having jurisdiction.

- b) Roof plan indication roof clip spacing pattern at field, corner, perimeters and where panels are to be fixed from thermal movement.

C. Samples:

1. Submit two samples, 12" long, full width panel, showing metal gauge, and seam.
2. Two samples each for roof panel clip, bearing plate and clip fastener.
3. Submit color samples for Architect and Pace's selection.
4. Submit sample warranties, as indicated in these specifications for the following:
 - a) Manufacturer Finish Warranty
 - b) Manufacturer Weathertightness Warranty complying with this Specification

D. Certificates:

1. Submit roof panel manufacturer's certification that fasteners, clips, backup plates, closures, roof panels and finishes meet the specification requirements.
2. Submit roof panel manufacturer's certification that installer meets requirements to install roof system and is qualified to obtain required warranties.

E. Test and Evaluation Reports - Certified test results that indicate roof system meets or exceeds design and performance criteria. Testing to include:

1. ASTM E1592 - Manufacturers test data, signed and sealed by a registered professional engineer, substantiating that roof system will meet the allowable wind pressures using an appropriate Factor of Safety in accordance with AISI S-100.

F. Qualification Statements: For Manufacturer and Installer complying with this specification.

1.6 INFORMATIONAL SUBMITTALS

A. Portable Roll-Forming Equipment Certificate: Issued by UL for equipment manufacturer's portable roll-forming equipment capable of producing panels that comply with UL requirements. Show expiration date no earlier than two months after scheduled completion of sheet metal roofing.

1. Submit certificates indicating recertification of equipment whose certification has expired during the construction period.

B. Qualification Data: For qualified Installer.

- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Manual indicating requirements and recommendations, to maintain the roof system in good working condition.
- B. Warranty Documentation: Submit final warranties required in this section.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Manufacturer shall have a minimum of ten years' experience in the manufacturing of metal roof systems similar to those required for this project. Manufacturer must have a current installer training program.
2. Installer Qualifications: Installer ("roofer") to perform the work of this section shall have no fewer than 5 years of successful experience with the installation of metal roof systems similar to those required for this project. The installer shall be qualified by the roof panel manufacturer for installation of manufacturer-warranted systems.

B. Preinstallation Conference: Before Starting Roof Decking Construction Conduct conference at Project site.

1. Meet with Pace, Architect, metal panel roofing Installer, and metal deck Installer, and installers whose work interfaces with or affects metal roofing system including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roof decking construction and sheet metal roofing including, but not limited to, items listed for the Preinstallation Conference.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review methods and procedures related to sheet metal roofing installation, including portable roll-forming equipment manufacturer's written instructions.
5. Examine metal deck conditions for compliance with requirements, including flatness and attachment to structural members.
6. Review structural loading limitations of metal deck during and after roofing installation.
7. Review flashings, special roofing details, roof drainage, roof penetrations, and condition of other construction that will affect sheet metal roofing.
8. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.

9. Review temporary protection requirements for sheet metal roofing during and after roofing installation.
 10. Review roof observation and repair procedures after sheet metal roofing installation.
 11. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
- C. Field Measurements: Prior to fabrication of panels, take field measurements of structure or substrates to receive panel system. Allow for trimming panel units, where final dimensions cannot be established prior to fabrication.
- D. Roll-Formed Sheet Metal Roofing Fabricator Qualifications: Fabricator authorized by portable roll-forming equipment manufacturer to fabricate and install sheet metal roofing units required for this Project, and who maintains current UL certification of its portable roll-forming equipment.
- E. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing roofing panels for sheet metal roofing assemblies that comply with UL 580 for Class 90 wind-uplift resistance. Maintain UL certification of portable roll-forming equipment for duration of sheet metal roofing work.
- F. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements: Deliver panels to jobsite properly packaged to provide protection against transportation damage. Panels too long to ship shall be site formed onto the roof by manufacturer's factory personnel using manufacturer's factory roll forming equipment.
- B. Storage and Handling Requirements:
1. Exercise care in unloading, storing and erecting panels to prevent bending, warping, twisting, and surface damage.
 2. Store all material and accessories above ground on well skidded platforms. Store under waterproof covering. Provide proper ventilation to panels to prevent condensation build-up between each panel.
 3. Remove from site and replace panels which are damaged, or become water-stained during storage and handling.

1.10 WARRANTIES

- A. Manufacturer Warranties:

1. Panel Coating: Furnish manufacturer's 30-year warranty panel coating warranty covering cracking, checking, and peeling, and 20 year warranty covering fade and chalk.
 - (1) Warranty term: Commencing on date of substantial completion.
 - (2) Total manufacturer's liability: NDL No Dollar Limit for material and labor
2. Metal Roof Weathertightness Warranty:
 - a) Manufacturer's Single Source Weathertightness Warranty
 - (1) Warranty term: 20 years commencing on date of substantial completion.
 - (2) Total manufacturer's liability: NDL No Dollar Limit for material and labor
 - (3) Warranty must cover: Wind Speeds up to 75 mph
 - (a) Manufacturer must supply engineered installation drawings signed and sealed by an engineer registered in the state in which the project is located.

PART 2 - PRODUCTS

- 2.1 Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to:
1. McElroy Metal.
 2. IMETCO.
 3. or equal.

2.2 ROOF PANEL SYSTEM

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Product Data
 1. Factory-formed panel, width of 24 inches. Panels shall be symmetrical in design and shall be mechanically seamed with a field operated electric seaming machine approved by the manufacturer.
 2. Seam height: 1 ½ inches.
 3. Seam cap matching panel finish with two rows of integral factory hot applied sealant. Sealant should not come in contact with clip, and clip should not require sealant to maintain a weathertight condition.

C. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
2. Thickness: Nominal 0.025 inch unless otherwise indicated.
3. Surface: Smooth, flat.
4. Exposed Coil-Coated Finish: Two-Coat Fluoropolymer:
 - a) AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
5. Color: Red- selected by Architect and Pace from manufacturer's full range.
6. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
7. Roof panel system must allow individual roof panel removal and replacement from any point on the roof without damage to adjacent roof panel(s).
8. Roof panel system must be approved by manufacturer to be installed on slopes as low as 1/2:12.
9. Panels must be furnished and installed in continuous lengths from ridge to eave with no overlaps. Panels too long to ship will be manufactured on site using manufacturer's employees and equipment.
10. Panel surface characteristics to be Smooth.
11. Manufacturer weathertightness warranty meeting requirements of this Section

2.3 PERFORMANCE/DESIGN CRITERIA

- A. Thermal Movement: Metal Roofing system, including flashing, shall accommodate unlimited thermal movement without buckling or excess stress on the structure.
- B. Roof panel and trim attachments will be designed to satisfy the requirements of the roof design (shown in shop drawings).
- C. Maximum wind uplift capacity of roof system shall be determined using ASTM E 1592 test results, with an appropriate Factor of Safety in accordance with AISI S-100.

- D. Panel system shall be designed in accordance with the local building code and ASCE7 for project location with respect to appropriate Exposure category, Importance Factor and Factor of Safety in accordance with AISI S-100.
- E. Tested and listed by Underwriters Laboratories to comply with UL 580 for wind uplift Class 90 rating.

2.4 UNDERLAYMENT MATERIALS

- A. Felts: ASTM D 226, Type II No. 30, asphalt-saturated organic felts.
 - 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F.
 - 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.
 - 3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a) Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT.
 - b) Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
 - c) Henry Company; Blueskin PE200 HT.
 - d) Metal-Fab Manufacturing, LLC; MetShield.
 - e) Owens Corning; WeatherLock Metal High-Temperature Underlayment.
 - f) or equal.

2.5 ACCESSORIES

- A. Panel Clip Screw - screw required in wind uplift rating requirements and design specification for application, with corrosion-resistant coating, in length necessary to penetrate substrate minimum 3/4 inch., as supplied by roof panel manufacturer.
- B. Roof Panel Clip:
 - 1. Intermittent Clip: 16 gauge galvanized steel, one-piece, designed to allow roof panel thermal movement and not contact roof panel cap, as supplied by roof panel manufacturer, meeting wind uplift requirements and design criteria of this section.
 - 2. Intermittent Clip Bearing Plate: If required, in gauge, size and finish as supplied by and approved by roof panel manufacturer for use in roof panel manufacturer's full assembly warranted systems.
 - 3. Multi-Span Clip: as provided by roof panel manufacturer for full assembly warranted systems.
- C. Trim and flashing will be of the same gauge and finish unless approved otherwise by the metal roof system manufacturer.

1. Ridge closures, consisting of metal channel surrounding factory pre-cut closed cell foam, will not be secured through the field of the panel.
 2. Trim will be installed specifically as displayed in the manufacturer provided shop drawings. Proposed changes must be approved in writing by the metal roof system manufacturer.
- D. Concealed supports, angles, plates, accessories and brackets: gauge and finish as recommended, and furnished by manufacturer.
- E. Accessory Screw: Size and screw type as provided by panel manufacturer for each use, with prefinished hex washer head in color to match panels where exposed to view.
- F. Rivets: full stainless steel, including mandrel, in size to match application.
- G. Field Sealant:
1. Exposed Sealant: Color coordinated urethane or polymer sealant as supplied by panel manufacturer.
 2. Non-exposed Sealant: Non-curing, non-skinning, butyl tape or tube sealant as supplied by manufacturer.
- H. Sealant Tape: non-drying, 100 percent solids, high grade butyl tape, as supplied by panel manufacturer, in sizes to match application.
- I. Pipe Penetration Flashings: 20 year warranted flexible boot type, with stainless steel compression ring. Use silicone type at hot pipes.

PART 3 - EXECUTION

3.1 INSTALLERS

- A. Must be certified and qualified by Manufacturer.

3.2 EXAMINATION

A. Verification of Conditions

1. Ensure surfaces are ready for panel application.
2. Inspect and ensure surfaces are free from objectionable warp, wave, and buckle before proceeding with installation of pre-formed metal roofing.
3. Ensure substrate is ready to receive metal roofing. Report items for correction and do not proceed with metal roof panel system installation until resolved.

3.3 PREPARATION

- A. Install substrate boards, hat channels, purlins, or furring channels in accordance with manufacturer's recommendations.
- B. Coordinate Work, with installation of other associated Work, to ensure quality application.
- C. Coordinate Work with installation of associated metal flashings and building walls.
- D. Coordinate Work to minimize foot traffic and construction activity on installed finished surfaces.
- E. Coordinate location of pipe penetrations to allow centering of pipe in panel.
- F. Coordinate location of roof curbs, to allow proper integration with roof panel seams.

3.4 INSTALLATION

- A. Comply with and install roofing and flashings in accordance with all details shown on manufacturer's approved shop drawings and manufacturer's product data, instructions, and installation manuals, within specified erection tolerances.
- B. Install field panels in continuous lengths, without endlaps
- C. Do not install panels damaged by shipment or handling.
- D. Install intermittent clips with bearing plates, if required, and continuous clips, if required, according to the engineered design pattern in the field, perimeter, and corner areas of the roof.
- E. Fix panels at location depicted on reviewed shop drawing(s).
- F. Fold up pan of panel at ridge, hip and headwalls. Commonly referred to as bread panning.
- G. Allow for required panel clearance at penetrations for thermal movement.
- H. Install concealed supports, angles and brackets as furnished by manufacturer to form complete assemblies.
- I. Remove roof panel and flashing protective film prior to extended exposure to sunlight, heat, and other weather elements.
- J. Field-apply sealant tape and gun-grade sealant according to reviewed shop drawings and manufacturer's requirements for airtight, watertight installation.
- K. Ensure sealant beads and tapes are applied prior to sheet metal installation to achieve a concealed bead. Neatly trim exposed portions of sealant without damaging roof panel or flashing finish.

- L. Align pipe penetrations to occur at center of roof panel. Report and have corrected improperly-placed penetrations before proceeding with panel installation. Remove and replace roof panels which have improperly-placed penetration flashings.
- M. Install sheet metal flashings according to manufacturer's recommendations, reviewed shop drawings.

3.5 CLEANING

- A. Clean exposed surfaces of work promptly after completion of installation.
- B. Clean mud, dirt, and construction-related debris from panels before panels are scratched or marred.

3.6 PROTECTION

- A. Protect Work as required to ensure roofing will be without damage at time of final completion.
- B. Do not allow excessive foot traffic over finished surfaces.
- C. Do not track mud, dirt, or construction-related debris onto panel surfaces.
- D. Replace damaged Work before final completion.

END OF SECTION 07411

INTENTIONALLY LEFT BLANK

SECTION 07413 METAL PANELS

PART 1 GENERAL

1.1 SUMMARY

A. SECTION INCLUDES

1. Metal panels, including trim and accessories

1.2 REFERENCES

- A. AISI S-100 – North American Specification for the Design of Cold-Formed Steel Structural Members.
- B. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding System by Uniform Static Air Pressure Difference
- C. ASTM E1680 - Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems.
- D. Factory Mutual 4471 Appendix G - Susceptibility to Leakage Test Procedure for Class 1 Panel Roofs.
- E. UL 580 - Tests for Uplift Resistance of Roof Assemblies.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meetings:

1. Schedule meeting to discuss metal panel project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements before start of work onsite.
2. Required attendees: Contractor, metal deck & roof installer, and any other subcontractors who have equipment penetrating the metal panel assembly or Work that requires roof access or traffic.

1.4 SUBMITTALS

- A. Product Data: Manufacturer literature indicating product specifications, installation instructions, and standard construction details for specified products.
- B. Shop Drawings: To be prepared by metal roof system manufacturer.
 1. Submit plan showing panel layout, profiles, components, accessories, finish colors, gutters and downspouts as applicable.
 - a) Indicate layout of metal panels and roof panel sizes, including custom fabricated panels as needed, indicate each trim condition.

- b) Include details of each condition of installation, including the locations and types of fasteners, sealants and accessories. Indicate locations, gauges, shapes, and methods of attachment of all panels, accessories and trim.
 - c) Indicate products/materials required for construction activities of this section not supplied by manufacturer of products of this section.
 - d) Indicate locations of field applied sealant.
 - e) Indicate locations of field worked conditions.
2. Panel Attachment:
- a) Plan with wind uplift pressure calculations at field, corner and perimeter areas according to version of ASCE-7 referenced by locally-adopted Building Code and the authority having jurisdiction.
 - b) Plan indication panel clip spacing pattern at field, corner, perimeters and where panels are to be fixed from thermal movement.
 - c) Panel attachment plan must be stamped by licensed engineer in State in which project is constructed, certifying roof attachment meets local Building Code requirements for wind uplift.

C. Samples:

- 1. Submit two samples, 12" long, full width panel, showing metal gage, and seam.
- 2. Two samples each for panel clip, bearing plate and clip fastener.
- 3. Submit color samples for Architect's selection.
- 4. Submit sample warranties:
 - a) Manufacturer Finish Warranty
 - b) Manufacturer Weathertightness Warranty complying with this Specification
 - c) Installer Warranty

D. Certificates:

- 1. Submit panel manufacturer's certification that fasteners, clips, backup plates, closures, roof panels and finishes meet the specification requirements.
- 2. Submit panel manufacturer's certification that installer meets requirements to install panel system and is qualified to obtain required warranties.

- E. Delegated Design Submittals: Submit engineering calculations indicating wind uplift pressure calculations according to local building code for project location with respect to appropriate Importance Factor, Exposure category and Safety Factor. Calculations shall be sealed by a professional engineer licensed to practice structural engineering in the state in which project is located.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Manual indicating requirements and recommendations, to maintain the roof system, in good working condition.
- B. Warranty Documentation: Submit final warranties required in this section.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Manufacturer shall have a minimum of ten years experience in the manufacturing of metal roof systems similar to those required for this project. Manufacturer must have a current installer training program.
2. Installer Qualifications: Installer ("roofer") to perform the work of this section, shall have no fewer than 5 years of successful experience with the installation of metal roof systems similar to those required for this project. The installer shall be qualified by the metal panel manufacturer for installation of manufacturer-warranted systems.

- B. Field Measurements: Prior to fabrication of panels, take field measurements of structure or substrates to receive panel system. Allow for trimming panel units, where final dimensions cannot be established prior to fabrication.

- C. Mock-Ups: Install a 30 foot wide, quality control area of metal panel system, for review by the Architect. The Architect shall approve the quality of installation for the project, prior to installing additional metal panels.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements: Deliver panels to jobsite properly packaged to provide protection against transportation damage. Panels too long to ship shall be site formed onto the roof by manufacturer's factory personnel using manufacturer's factory roll forming equipment.

B. Storage and Handling Requirements:

1. Exercise care in unloading, storing and erecting panels to prevent bending, warping, twisting, and surface damage.

2. Store all material and accessories above ground on well skidded platforms. Store under waterproof covering. Provide proper ventilation to panels to prevent condensation build-up between each panel.
3. Remove from site and replace panels which are damaged, or become water-stained during storage and handling.

1.8 WARRANTIES

A. Manufacturer Warranties:

1. Panel Material: Furnish manufacturers 25 year warranty covering the panel against rupture, structural failure, or perforation.
2. Panel Coating: Furnish manufacturer's 40-year warranty panel coating warranty covering cracking, checking, and peeling, and 30 year warranty covering fade and chalk.
3. Metal Weathertightness Warranty:
 - a) Manufacturer's Single Source Weathertightness Warranty
 - (1) Warranty term: 20 years commencing on date of substantial completion.
 - (2) Total manufacturer's liability: NDL No Dollar Limit for material and labor.
 - (3) Warranty must cover: Wind Speeds up to 75 mph
 - (a) Manufacturer must supply engineered installation drawings signed and sealed by an engineer registered in the state in which the project is located.

PART 2 - PRODUCTS

2.1 PANEL SYSTEM

- A. Basis of Design Manufacturer: Must be same as Metal Roof Panel Manufacturer; McElroy Metal, IMETCO, or equal.
- B. Product Options
 1. Factory-formed panel, width of 24 inches. Panels shall be symmetrical in design and shall be mechanically seamed with a field operated electric seaming machine approved by the manufacturer.
 2. Minimum seam height 2 3/8 inches. Integral seam, double lock and snap together type panels are not acceptable

3. Seam cap matching panel finish with two rows of integral factory hot applied sealant. Sealant should not come in contact with clip, and clip should not require sealant to maintain a weathertight condition.
4. Galvalume coated sheet steel, Type AZ-50, Grade 50 as described in ASTM A792; 24 gauge.
5. Finish: Two coat coil applied, baked-on full-strength (70% resin, PVF2) fluorocarbon coating consisting of a nominal 0.25 mil dry film thickness primer, and a nominal dry film thickness of 0.7 - 0.8 mil color coat for a total 0.9 to 1.1 mil total system dry film thickness. Finish to be selected from manufacturer's standard color selection. The back side of the material should be 0.25 mil primer and 0.25 mil polyester wash coat.
6. Panel system must allow individual panel removal and replacement from any point on the roof without damage to adjacent roof panel(s).
7. Panels must be furnished and installed in continuous lengths from ridge to eave with no overlaps. Panels too long to ship will be manufactured on site using manufacturer's employees and equipment.
8. Panel surface characteristics to be Striated
9. Manufacturer weathertightness warranty meeting requirements of this Section.

2.2 PERFORMANCE/DESIGN CRITERIA

- A. Thermal Movement: Metal Roofing system, including flashing, shall accommodate unlimited thermal movement without buckling or excess stress on the structure.
- B. Panel and trim attachments will be designed to satisfy the requirements of the design (shown in shop drawings).
- C. Maximum wind uplift capacity of roof system shall be determined using ASTM E 1592 test results, with an appropriate Factor of Safety in accordance with AISI S-100.
- D. Panel system shall be designed in accordance with the local building code and ASCE7 for project location with respect to appropriate Exposure category, Importance Factor and Factor of Safety in accordance with AISI S-100.
- E. Tested and listed by Underwriters Laboratories to comply with UL 580 for wind uplift Class 90 rating.

2.3 ACCESSORIES

- A. Panel Clip Screw - screw required in wind uplift rating requirements and design specification for application, with corrosion-resistant coating, in length necessary to penetrate substrate minimum 3/4 inch., as supplied by metal panel manufacturer.
- B. Panel Clip:

1. Intermittent Clip: 16 gauge galvanized steel, one-piece, designed to allow panel thermal movement and not contact panel cap, as supplied by panel manufacturer, meeting wind uplift requirements and design criteria of this section.
 2. Multi-Span Clip: as provided by panel manufacturer for full assembly warranted systems.
- C. Trim and flashing will be of the same gauge and finish.
1. Ridge closures, consisting of metal channel surrounding factory precut closed cell foam, will not be secured through the field of the panel.
 2. Trim will be installed specifically as displayed in the manufacturer provided shop drawings. Proposed changes must be approved in writing by the metal panel system manufacturer.
- D. Concealed supports, angles, plates, accessories and brackets: gauge and finish as recommended, and furnished by manufacturer.
- E. Accessory Screw: Size and screw type as provided by panel manufacturer for each use, with prefinished hex washer head in color to match panels where exposed to view.
- F. Rivets: full stainless steel, including mandrel, in size to match application.
- G. Field Sealant:
1. Exposed Sealant: Color coordinated urethane or polymer sealant as supplied by panel manufacturer.
 2. Non-exposed Sealant: Non-curing, non-skinning, butyl tape or tube sealant as supplied by manufacturer.
- H. Sealant Tape: non-drying, 100 percent solids, high grade butyl tape, as supplied by panel manufacturer, in sizes to match application.
- I. Pipe Penetration Flashings: 20 year warranted flexible boot type, with stainless steel compression ring. Use silicone type at hot pipes.

PART 3 - EXECUTION

3.1 INSTALLERS

- A. Must be certified and qualified by Manufacturer.

3.2 EXAMINATION

- A. Verification of Conditions
1. Ensure surfaces are ready for panel application.

2. Inspect and ensure surfaces are free from objectionable warp, wave, and buckle before proceeding with installation of pre-formed metal roofing.
3. Ensure substrate is ready to receive metal roofing. Report items for correction and do not proceed with metal roof panel system installation until resolved.

3.3 PREPARATION

- A. Install substrate boards, hat channels, purlins, or furring channels in accordance with manufacturer's recommendations.
- B. Coordinate Work, with installation of other associated Work, to ensure quality application.
- C. Coordinate Work with installation of associated metal flashings and building walls.
- D. Coordinate Work to minimize foot traffic and construction activity on installed finished surfaces.
- E. Coordinate location of pipe penetrations to allow centering of pipe in panel.

3.4 INSTALLATION

- A. Comply with and install roofing and flashings in accordance with all details shown on manufacturer's approved shop drawings and manufacturer's product data, instructions, and installation manuals, within specified erection tolerances.
- B. Install field panels in continuous lengths, without endlaps
- C. Do not install panels damaged by shipment or handling.
- D. Fix panels at location depicted on reviewed shop drawing(s).
- E. Fold up pan of panel at ridge, hip and headwalls. Commonly referred to as breadpanning.
- F. Allow for required panel clearance at penetrations for thermal movement.
- G. Install concealed supports, angles and brackets as furnished by manufacturer to form complete assemblies.
- H. Remove panel and flashing protective film prior to extended exposure to sunlight, heat, and other weather elements.
- I. Field-apply sealant tape and gun-grade sealant according to reviewed shop drawings and manufacturer's requirements for airtight, watertight installation.
- J. Ensure sealant beads and tapes are applied prior to sheet metal installation to achieve a concealed bead. Neatly trim exposed portions of sealant without damaging roof panel or flashing finish.

- K. Align pipe penetrations to occur at center of roof panel. Report and have corrected improperly-placed penetrations before proceeding with panel installation. Remove and replace roof panels which have improperly-placed penetration flashings.
- L. Install sheet metal flashings according to manufacturer's recommendations, reviewed shop drawings and in accordance with provision of Section 07 62 00.

3.5 CLEANING

- A. Clean exposed surfaces of work promptly after completion of installation.
- B. Clean mud, dirt, and construction-related debris from panels before panels are scratched or marred.

3.6 PROTECTION

- A. Protect Work as required to ensure roofing will be without damage at time of final completion.
- B. Do not allow excessive foot traffic over finished surfaces.
- C. Do not track mud, dirt, or construction-related debris onto panel surfaces.
- D. Replace damaged Work before final completion.

END OF SECTION

SECTION 07920 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- a. Drawings and general provisions of Contract apply to this Section.

1.2 SUMMARY

- A. This Section includes sealants for the following applications, including those specified by reference to this Section:
 1. Exterior joints in the following vertical surfaces and nontraffic horizontal surfaces:
 - a. Control and expansion joints in cast-in-place concrete, except pavement, walkway and curbing that are covered in other specification sections.
 - b. Control and expansion joints in unit masonry.
 - c. Joints between different materials indicated.
 - d. Perimeter joints between materials listed above and frames of doors and windows.
 - e. Control and expansion joints in ceiling and overhead surfaces.
 - f. Other joints as indicated.
 2. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Perimeter joints of exterior openings where indicated.
 - b. Vertical control joints on exposed surfaces of interior unit masonry and concrete walls and partitions.
 - c. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and entrances.
 - d. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - e. Other joints as indicated.
 3. Interior joints in the following horizontal traffic surfaces:
 - a. Control and expansion joints as indicated.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
 - 2. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F.
 - 3. When joint substrates are wet.
- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Silicone containing products are not permitted except for use in exterior assemblies on Administration Buildings and when required by the system manufacturer for weathertight warranty.
- B. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- C. Colors of Exposed Joint Sealants: Manufacturer's standard color that is the closest to the lightest adjacent substrate.

2.2 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealant Standard: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant in the Elastomeric Joint-Sealant Schedule at the end of Part 3, including those referencing ASTM C 920 classifications for type, grade, class, and uses.
 - 1. Multicomponent Nonsag Urethane Products: 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. Dynatrol II; Pecora Corporation.
 - b. Flexiprene 2000; Polymeric Systems, Inc.
 - c. Sikaflex - 2c NS; Sika Corporation.
 - d. NP 2; Sonneborn Building Products Div., ChemRex Inc.
 - e. Dymeric 511; Tremco.
 - f. or equal.
 - 2. Multicomponent Pourable Urethane Products: 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. Chem-Calk 550; Bostik Inc.
 - b. Vulkem 245; Mameco International.
 - c. Pourthane; W.R. Meadows, Inc.
 - d. Elasto-Thane 920 Pourable; Pacific Polymers, Inc.

- e. NR-200 Urexpam; Pecora Corporation.
 - f. PSI-270SL; Polymeric Systems, Inc.
 - g. Sikaflex - 2c SL; Sika Corporation.
 - h. SL 2; Sonneborn Building Products Div., ChemRex Inc.
 - i. THC-900; Tremco.
 - j. or equal.
3. Single-Component Nonsag Urethane Products: 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. Chem-Calk 900; Chem-Calk 915; or Chem-Calk 945; Bostik Inc.
 - b. Vulkem 921; Mameco International.
 - c. PR-255; Ohio Sealants, Inc.
 - d. Dynatrol I; Pecora Corporation.
 - e. Flexiprene 1000; or PSI-901; Polymeric Systems, Inc.
 - f. SM7100 Permathane; Schnee-Morehead, Inc.
 - g. DyMonic; Tremco.
 - h. or equal.
4. Single-Component Pourable Products: 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. Chem-Calk 950; Bostik Inc.
 - b. Vulkem 45; Mameco International.
 - c. Vulkem Nova 300 SSL; Mameco International.
 - d. NR-201; Pecora Corporation.
 - e. Flexiprene PSI-951; Polymeric Systems, Inc.
 - f. SL 1; Sonneborn Building Products Div., ChemRex Inc.
 - g. or equal.
- B. Additional Movement Capability: Where additional movement capability is specified in the Elastomeric Joint-Sealant Schedule, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the specified percentage change in the joint width existing at the time of installation and remain in compliance with other requirements of ASTM C 920 for uses indicated.
- C. Stain-Test-Response Characteristics: Where elastomeric sealants are specified in the Elastomeric Joint-Sealant Schedule to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. Continuous-Immersion-Test-Response Characteristics: Where elastomeric sealants will be immersed continuously in water, provide products that have undergone testing according to ASTM C 1247, including initial six-week immersion period and additional immersion periods specified below, and have not failed in adhesion or cohesion when tested with substrates indicated for Project.

2.3 LATEX JOINT SEALANTS

- A. Latex Sealant Standard: Comply with ASTM C 834.
1. Products: 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. Chem-Calk 600; Bostik Inc.
 - b. NuFlex 330; NUCO Industries, Inc.
 - c. LC 160 All Purpose Acrylic Caulk; Ohio Sealants, Inc.

- d. AC-20; Pecora Corporation.
- e. PSI-701; Polymeric Systems, Inc.
- f. Sonolac; Sonneborn Building Products Div., ChemRex, Inc.
- g. Tremflex 834; Tremco.
- h. or equal.

2.4 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 - 1. Type C: Closed-cell material with a surface skin.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints. Leave no residue.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
 - a. Concrete.
 - b. Masonry.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
 - a. Metal.
 - b. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.
- E. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses provided for each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 1. Remove excess sealants from surfaces adjacent to joint.

2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
- G. Installation of Preformed Expanding Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, producing seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in compliance with sealant manufacturer's written instructions.

3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

3.6 JOINT-SEALANT SCHEDULE

- A. Multicomponent Nonsag Urethane Sealant
1. Applications: Exterior vertical joints between different materials or systems.
 2. Type and Grade: M (multicomponent) and NS (nonsag).
 3. Class: 25.
 4. Additional Movement Capability: 50 percent movement in extension and 50 percent in compression for a total of 100 percent movement.
 5. Use Related to Exposure: NT (nontraffic).
 6. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: Color anodic aluminum, galvanized steel, and ceramic tile.
- B. Multicomponent Pourable Urethane Sealant
1. Applications: Exterior pavement joints between threshold and sidewalk or door pads. Horizontal traffic surfaces of Toilet Rooms; except at fixtures.
 2. Type and Grade: M (multicomponent) and P (pourable).
 3. Class: 25.
 4. Use Related to Exposure: T (traffic).
 5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.
- C. Single-Component Nonsag Urethane Sealant
1. Applications: Vertical surfaces in toilet rooms where toilet fixtures and accessories meet adjacent surfaces.
 2. Type and Grade: S (single component) and NS (nonsag).
 3. Class: 25.
 4. Use Related to Exposure: NT (nontraffic).

5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: Ceramic tile, and porcelain.

D. Single-Component Pourable Urethane Sealant

1. Applications: Interior floor slab joints not having floor slab specified per Division 3 Section "Concrete Floor Slabs," and between threshold and sidewalk or door pads.
2. Type and Grade: S (single component) and P (pourable).
3. Class: 25.
4. Use Related to Exposure: T (traffic).
5. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

E. Latex Sealant

1. Applications: General Interior joints on vertical substrates.

END OF SECTION 07920

INTENTIONALLY LEFT BLANK

SECTION 08111 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes hollow-metal work.
- B. Related Requirements:
 - 1. Section 08710 "Door Hardware" for door hardware for hollow-metal doors

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, and finishes.
- B. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Chicago Hollow Metal, Inc.
 - 2. Goldy Locks
 - 3. J&L Metal Doors
 - 4. LaForce, Inc.
 - 5. Preferred Window and Door
 - 6. Steelcraft; an Ingersoll-Rand company
 - 7. or equal.

2.2 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Hollow-Metal Doors and Frames: NAAMM-HMMA 860. At locations indicated in the Door and Frame Schedule.
 - 1. Physical Performance: Level A according to SDI A250.4.
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches
 - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, with minimum G60 or A60 coating.
 - d. Edge Construction: Tack welded with no visible seam.
 - e. Core: Steel stiffened.

- 1) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

3. Frames:

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum G60 or A60 coating.
- b. Construction: Face welded.

4. Finish: Prime.

5. Finish Paint: Acrylic semi-gloss paint, red.

2.3 HOLLOW-METAL PANELS

- A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.5 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

- C. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- G. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

2.6 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
 - 1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
 - 2. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches.
 - 3. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.
 - 4. Bottom Edge Closures: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.
 - 5. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 6. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

- C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated
 2. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 3. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
 4. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
 - 1) Four anchors per jamb from 90 to 120 inches high.
 - b. Compression Type: Not less than two anchors in each frame.
 - c. Post installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
 5. Head Anchors: Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.
 6. Terminated Stops: Terminate stops 6 inches above finish floor with a 90-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

2.7 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate-free primer complying with SDI A250.10; recommended by primer manufacture for substrate and field-applied coatings despite prolonged exposure.

2.8 ACCESSORIES

- A. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

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 embedded and built-in anchors to verify actual locations before frame installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces
 - b. Install frames with removable stops located on secure side of opening.
 - c. Install door silencers in frames before grouting.

- d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - e. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - f. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post installed expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of post installed expansion anchors if so indicated and approved on Shop Drawings.
 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 4. In-Place Concrete or Masonry Construction: Secure frames in place with post installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 5. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Steel Doors:
 - a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
 - c. At Bottom of Door: 3/4 plus or minus 1/32 inch.
 - d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- E. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- F. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08111

SECTION 08311 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Non-fire rated ceiling access panels.

1.2 COORDINATION

- A. Provide inserts and anchoring devices that will be built into other Work for installation of access door assemblies.
- B. Coordinate delivery with other Work to avoid delay.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's technical data for each type of access door and panel assembly, including setting drawings, templates, fire-resistive characteristics, finish requirements, and details of anchorage devices.
 - 1. Include complete schedule, types, locations, construction details, finishes, latching or locking provisions, and other pertinent data.
- B. Manufacturer's Installation Instructions: Indicate installation requirements and rough-in dimensions.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Package and ship per manufacturer's recommendations.
- B. Store per manufacturer's instructions.
 - 1. Store in dry area out of direct sunlight.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Nystrom Building Products
 - 2. or equal.

2.2 DESIGN REQUIREMENTS:

- A. Obtain specific locations and sizes for required access doors and frames from trades, including mechanical and electrical, requiring access to concealed equipment and indicate on submittal schedule.

2.3 MATERIALS

- A. Commercial quality, cold steel sheet with gray baked on powder coat finish.

2.4 ACCESS PANELS

- A. Non rated flush access doors
 - 1. Door: Fabricate from 14-gage cold rolled sheet steel, insulated sandwich type construction.

2. Frame: Fabricate from 16-gage cold rolled sheet steel. Provide 1/4 inch mounting holes and easy install tabs.
 - a. 1 inch flange at perimeter.
3. Hinge:
 - a. Concealed spring button type to allow for door removal.
4. Latching/Locking Devices: Screwdriver cam latch - standard.
5. Finish:
 - a. White baked on powder coat finish.

2.5 FABRICATION

- A. Manufacture each access panel assembly as an integral unit ready for installation.
- B. Welded construction: Furnish with a sufficient quantity of 1/4 inch mounting holes to secure access panels to types of supports indicated.
- C. Recessed panel: Form face of panel to provide specified recess for application of finish material. Reinforce panel as required to prevent buckling.
- D. Furnish number of latches required to hold door in flush, smooth plane when closed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that rough openings for door and frame are correctly sized and located.
- B. Verify mechanical and electrical requirements for ceiling or wall access panels.

3.2 INSTALLATION

- A. Install access door and frame units per manufacturer's written instructions.
- B. Install frames plumb and level in opening. Secure rigidly in place.
- C. Position units to provide convenient access to concealed Work requiring access.

3.3 ADJUSTING AND CLEANING

- A. Adjust panel after installation for proper operation.
- B. Remove and replace panels or frames that are warped, bowed, or damaged.

END OF SECTION 08311

SECTION 08451- PLASTIC GLAZING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Polycarbonate panel system.

1.2 REFERENCES

- A. ASTM E 84 - Surface Burning Characteristics of Building Materials.
- B. ASTM D 635 - Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
- C. ASTM D 1929 – Ignition Temperature of Plastics.
- D. ASTM D 2843 – Density of Smoke.

1.4 DESIGN REQUIREMENTS

- A. Basic Wind Speed: 90 mph.
- B. Maximum Allowable Deflection of Structural Members: Maximum of L/100 of clear span.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including materials, components, fabrication, finish and installation instructions.
- C. Shop Drawings: Submit manufacturer's shop drawings, including plans, elevations, sections, and details, indicating dimensions, tolerances, profiles, anchorage, connections, fasteners, hardware, provisions for expansion and contraction, drainage, flashing, finish, and attachments to supports of glazing, framing, and options.
- D. Samples: Submit manufacturer's samples for each panel type, framing system, finish, and color specified.
- E. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
- F. Manufacturer's Project References: Submit list of completed projects including project name and location, name of architect, and type of panel manufactured.
- G. Warranty: Submit manufacturer's sample standard warranty.

- H. Testing Reports: Submit manufacturer's test reports.
 - a. Fire tests.
 - b. Air infiltration test.
 - c. Water penetration test.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Continuously engaged in polycarbonate panel manufacturing with a minimum of 10 years successful experience.
 - 2. Able to demonstrate successful performance on comparable projects.
 - 3. Responsible for all components, including structural design.
- B. Installer's Qualifications:
 - 1. Authorized by manufacturer to install polycarbonate panel products.
 - 2. Trained by manufacturer's standard training methods and policies.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name, manufacturer, and location of installation.
- B. Storage:
 - 1. Store materials in a clean, dry area indoors in accordance with manufacturer's instructions.
 - 2. Keep temporary protective coverings in place.
 - 3. Do not expose panels to direct sunlight for extended periods.

1.8 WARRANTY

- A. Warranty Period: Ten years material and labor on weatherization starting on date of substantial completion.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Duo-Gard Industries Inc.
 - b. Solar Innovations
 - c. Extech
 - d. CO-EX Corporation
 - e. or equal.

2.2 SYSTEM

- A. Product: Base plate, pressure plate and cap system glazed with polycarbonate structured sheet. Glass fiber reinforced thermoset resin (fiberglass) faces are not acceptable.
 - a. Air Infiltration, ASTM E 283-04 2012: Leakage not to exceed 0.05 when tested at 1.57 PSF and not to exceed 0.07 when tested at 6.24 PSF.
 - b. Water Penetrations, ASTM E 331 and E547– 2009: No water leakage at 7.5 PSF.
 - c. Air Pressure Difference: ASTM E330-02 2010 No damage at 75 PSF.
 - d. Impact Testing:
 - i. Small Missile, ASTM 1886.
 - ii. Windborne Debris, ASTM 1996.

2.3 POLYCARBONATE PANEL

- A. Sheet Thicknesses: 40 mm, or as indicated on drawings.
- B. Profile: tongue and groove
- D. Color: manufacturer's standard - Red and Opal, as specified on drawings.
- E. U-Value, ASTM C 1363-2011: 0.28
- F. Light Transmission:
 - a. NFRC 202-2012 Visible Transmittance at Normal Incidence: 30% (opal).
- G. Fire Tests:
 - 1. Flame Spread, ASTM E 84: Class A.
 - 2. Smoke Density, ASTM E 84: Class A.
 - 3. Smoke Developed, ASTM D 635: CC1.
 - 4. Ignition Temperature, ASTM D1929.
 - 5. Density of smoke, ASTM D 2843.
- H. Sheet widths: 19.7 inches, up to 42 inches

2.4 STRUCTURAL FRAMING SYSTEM

- A. Framing System: Base plate, pressure plate and cap system.
 - 1. Alloy: 6063 T5.
- B. Combined Maximum Deflection: Not to exceed 1 inch for clear span under 24 feet.
- C. Provide aluminum framing as indicated in the Drawings.
- D. Glazing system required 8 feet (vertical) without additional support.
- E. Air Infiltration, ASTM E 283-1999: Leakage not to exceed 0.05 when tested at 1.57 PSF and not to exceed 0.07 when tested at 6.24 PSF.
- F. Water Penetrations, ASTM E 331 – 2000: No water leakage at 30 PSF.

2.5 MATERIALS

A. Glazing Panels:

1. Panels: Polycarbonate structured sheets.
2. UV Stabilization: Coextruded into panels, not coated.
3. Resist Yellowing: Maximum 10 delta for a minimum of 10 years.
4. Sheet Appearance: Uniform in color.
5. Expansion and Contraction: Design and install components with provisions for expansion and contraction due to a 120 degree F temperature variation.
6. Gaskets and Dry Seals: EPDM.

B. Joint Sealant:

1. Factory-Applied Sealant: Gunnable, nonhardening, elastomeric sealant. ASTM C 920, Type S, Class 12, Grade NS. Fed Spec TT-S-1657, Type 1.n.

C. Field Fasteners:

1. Comply with manufacturer's instructions for fastener types, quantities, and usage.
2. Cadmium-plated or better. Prevent oxidation or electrolytic interaction with framing.
3. Aluminum-to-Aluminum Connections: Self-drilling screws, No. 10 and No. 12, of sufficient length for full-thread engagement, as determined by manufacturer.

2.6 COLOR AND FINISH

A. Panel Color:

1. Manufacturer's standard- Red and Opal, as specified on drawings.

B. Aluminum Finish:

1. Clear anodized.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive polycarbonate panels. Notify Architect and/or Pace of conditions that would adversely affect installation or subsequent utilization of polycarbonate panel system. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Ensure supports to receive polycarbonate panels are clean, flat, level, plumb, square, accurately aligned, and correctly located.

3.3 INSTALLATION

- A. Install polycarbonate panels in accordance with manufacturer's instructions at locations indicated on the drawings.

- B. Install polycarbonate panels level, plumb, square, accurately aligned, correctly located, and without warp.
- C. Anchor polycarbonate panels securely in place to supports. Use attachment methods permitting adjustment for construction tolerances, irregularities, alignment, and expansion and contraction.
- D. Install polycarbonate panels including flashing, fasteners, hardware, gaskets, joint sealants, and glazing materials required for a complete, weathertight installation.
- F. Joint Sealants: Install a one part, low modulus, waterborne acrylic co-polymer joint as specified by manufacturer.
- G. Repair minor damages to metal finish or glazing in accordance with manufacturer's instructions and as approved by Architect and/or Pace. Remove and replace damaged components that cannot be successfully repaired as determined by Architect and/or Pace.

3.4 CLEANING

- A. Clean polycarbonate panels in accordance with manufacturer's instructions.
- B. Remove temporary protective coverings immediately after each panel is installed (exterior).
- C. Remove excess joint sealant in accordance with sealant manufacturer's instructions.
- D. Do not use harsh cleaning materials or methods that would damage metal finish or glazing.

3.5 PROTECTION

- A. Protect installed polycarbonate panels from damage during construction.
- B. Remove and replace damaged polycarbonate panel components as determined by Architect and/or Pace.

END OF SECTION 08451

INTENTIONALLY LEFT BLANK

SECTION 08710 – DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Mechanical and door hardware for:
 - a. Swinging doors.

1.2 REFERENCES

- A. Fire/Life Safety
 - 1. NFPA - National Fire Protection Association
 - 2. NFPA 101 - Life Safety Code
- B. Accessibility
 - 1. ADA - Americans with Disabilities Act
 - 2. Illinois Accessibility Code
- C. DHI - Door and Hardware Institute
 - 1. Sequence and Format for the Hardware Schedule
 - 2. Recommended Locations for Builders Hardware
 - 3. Key Systems and Nomenclature
- D. ANSI - American National Standards Institute
 - 1. ANSI/BHMA A156.1 - A156.29, and ANSI A156.31 - Standards for Hardware and Specialties

1.3 SUBMITTALS

- A. General:
 - 1. Submit in accordance with requirements as specified.
 - 2. Highlight, encircle, or otherwise specifically identify on submittals deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
 - 3. Prior to forwarding submittal, comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
- B. Action Submittals:
 - 1. Product Data: Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
 - 2. Warranty: Sample manufacturer's warranty as specified in this Section.

- C. Closeout Submittals:
 - 1. Operations and Maintenance Data : Provide in accordance:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Name, address, and phone number of local representative for each manufacturer.
 - d. Parts list for each product..
 - e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Qualified tradesmen, skilled in application of commercial grade hardware with record of successful in-service performance for installing door hardware similar in quantity, type, and quality to that indicated for this Project.
- B. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.
- B. Project Conditions:
 - 1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
 - 2. Provide secure lock-up for door hardware delivered to Project, but not yet installed. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- C. Protection and Damage:
 - 1. Promptly replace products damaged during shipping.
 - 2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work.
 - 3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- D. Deliver keys to subsequent delivery to Owner.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Years from date of Substantial Completion, for durations indicated.
 - a. Closers:
 - 1) Mechanical: 10 years.
 - b. Exit Devices:
 - 1) Mechanical: 3 years.
 - B. Locksets:
 - 1) Mechanical: 3 years.
 - C. Key Blanks:
 - 1) Lifetime

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers shall be in accordance with QUALITY ASSURANCE article, herein.
- B. Approval of products from manufacturers indicated as “Acceptable Manufacturer” is contingent upon those products providing all functions and features and meeting all requirements of scheduled products.

Item	Scheduled Manufacturer	Acceptable Manufacturer
Continuous Hinges	Ives (IVE)	Markar, Hager, McKinney, or equal
Locksets	Schlage (SCH)	Corbin Russwin, Sargent, or equal
Cylinders & Keying	Best (BEST)	No equivalent or substitution is permitted
Door Closers	LCN (LCN)	Sargent, Norton, or equal
Stops	Ives (IVE)	Hiawatha, Trimco, Rockwood, or equal
Thresholds & Weatherstrip	National Guard (NGP)	Reese, Zero, Pemko, or equal

- C. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
- D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect and Pace’s approval.

2.2 MATERIALS

- A. Fasteners

1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
 2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
 3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect and Pace if thru-bolts are required.
 4. Install hardware with fasteners provided by hardware manufacturer.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.3 MORTISE LOCKS

- A. Manufacturers and Products:
1. Scheduled Manufacturer and Product: Schlage L9000 series, or equal.
 2. Manufacturers and Products include, but not limited to: Corbin Russwin, Sargent, or equal
- B. Requirements:
1. Provide mortise locks certified as ANSI A156.13, Grade 1 Operational, Grade 1 Security, and manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
 2. Provide locks with standard 2-3/4 inches backset with full 3/4 inch throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1 inch throw, constructed of stainless steel.
 3. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
 - a. Lever Design includes, but not limited to: Schlage 06A.

2.4 CYLINDERS

- A. Manufacturer:
1. Scheduled Manufacturer: Best, no equivalent or substitution is permitted.
 2. Requirements: Provide cylinders/cores complying with the following requirements.

- a. Cylinders/cores compliant with ANSI/BHMA A156.5; latest revision, Section 12, Grade 1; permanent cylinders; cylinder face finished to match lockset, manufacturer's series as indicated.
- 3. Small format interchangeable core cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
- B. Nickel silver bottom pins.
- C. Failure to comply with stamping requirements shall be cause for replacement of cylinders/cores involved at no additional cost to Owner.
 - 1. Forward cylinders/cores to Owner, separately from keys, by means as directed by Owner.

2.5 KEYING

- A. Keying System: Factory registered, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Keying Requirements – General
 - 1. Permanent cylinders/cores keyed by the manufacturer according to the following key system.
- C. Keying system as directed by Pace.
- D. Key Features: Provide keys with the following features.
- E. Keys
 - 1. Material: Nickel silver; minimum thickness of .107-inch
- F. Coordinate with cylinder/core and key identification requirements above.

2.6 DOOR CLOSERS

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: LCN 4010/4110 series, or equal.
 - 2. Manufacturers and Products include, but are not limited to: Sargent 281/281P10 series, Norton 9500 Series, or equal.
- B. Requirements:
 - 1. Provide door closers certified to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
 - 2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
 - 3. Cylinder Body: 1-1/2 inch diameter, with 11/16 inch diameter double heat-treated pinion journal.

4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves with separate adjustment for latch speed, general speed, and back check.
7. Provide closers with a solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.7 DOOR STOPS

- A. Manufacturers:
 1. Scheduled Manufacturer: Ives, or equal.
 2. Manufacturers include, but are not limited to: Hiawatha, Trimco, Rockwood, or equal.
- B. Provide door stops at each door leaf:
 1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
 2. Where a wall stop cannot be used, provide universal floor stops for low or high rise options.
 3. Where wall or floor stop cannot be used, provide medium duty surface mounted overhead stop.

2.8 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

- A. Manufacturers:
 1. Scheduled Manufacturer: National Guard, or equal.
 2. Manufacturers include, but are not limited to: Reese, Zero, Pemko, or equal.
- B. Requirements:
 1. Provide thresholds, weather stripping (including door sweeps, seals, astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
 2. Size of thresholds:
 - a. Saddle Thresholds: 1/2 inch high by jamb width by door width

- b. Bumper Seal Thresholds: 1/2 inch high by 5 inches wide by door width
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.

C. FINSHES

- D. Finish: BHMA 626/652 (US26D); except:
1. Door Closers: Powder Coat to Match
 2. Weatherstripping: Clear Anodized Aluminum

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to installation of hardware, 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.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Where on-site modification of doors and frames is required:
 1. When modifications are exposed to view, use concealed fasteners, when possible.
 2. Prepare hardware locations in accordance with:
 - 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.
 2. Custom Steel Doors and Frames: HMMA 831.
- B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- H. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as indicated in keying section.
- I. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Closers shall not be visible in corridors, lobbies and other public spaces unless approved by Architect.
- J. 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 may impede traffic or present tripping hazard.
- K. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

3.4 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.

3.5 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 door hardware is without damage or deterioration at time of Substantial Completion.

END OF SECTION 08710

SECTION 08900 – GLAZED CURTAIN WALL – (PARTIAL HEIGHT)

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Documents:
 - 1. Drawings and general provisions of the Subcontract apply to this Section.
 - 2. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- B. Section Includes:
 - 1. Partial height glass wall
- C. Glass and glazing is specified with the following components. Unless otherwise noted, glass and glazing specified elsewhere shall conform to materials and glazing requirements and procedures specified in this Section.

1.2 REFERENCES

- A. "Safety Standard for Architectural Glazing Materials (16 CFR 1201) CI and CII issued by the Consumer Product Safety Commission.
- B. ANSI Z 97.1, "Safety Glass Test Requirements".
- C. ASTM International.
 - 1. ASTM C864 Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
 - 2. ASTM C1048 Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass
 - 3. ASTM A 6 Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.

1.3 GLAZED CURTAIN WALL DESCRIPTION

- A. Install each piece of glass. Each installation shall withstand local, normal temperature changes, wind loading, impact loading without failure of any kind, including loss or breakage of glass, failure of sealants or gaskets, deterioration of glazing materials, and other defects of work.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's product data, material safety data sheets, and specifications for installations indicated, listing specific materials proposed. Show that products supplied meet or exceed the specified requirements. Indicate completely,

recommendations for use of primers, joint preparation and sealant dimensions, and shall state shelf life for the material.

- B. Shop Drawings: Submit dimensioned drawings of glass wall assemblies including, but not limiting:
 - 1. Plans, elevations and details of product showing component dimensions; framed opening requirements, dimensions, tolerances, and attachment to structure and adjacent materials and assemblies.
- C. Certifications:
 - 1. Certification that all sealants are fully compatible with the surfaces and finishes with which they are in contact.

1.5 QUALITY ASSURANCE

- A. Safety glass standard: Provide tempered glass components that comply with ANSI Z97.1 and testing requirements of CPSC 16 CFR 1201 Category II.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Package and deliver glass in manufacturer's sealed unopened containers, fully identified, and each pane clearly labeled with manufacturer's name and product designation.
- B. Protect glass from damage and store in accordance with manufacturer's recommendations. Keep handling to a minimum. Protect edges of laminated and insulated glass from damage.
- C. Glazing Sealants:
 - 1. Deliver sealants and related accessories to the job site in factory sealed, unopened containers bearing manufacturer's name, product designation and batch number.
 - 2. Store in unopened containers. Follow manufacturer's recommendations for storage temperatures and shelf life (see "Submittals" above).
 - 3. Follow manufacturer's recommendations for handling products containing toxic materials. Keep flammable material away from heat, sparks and open flame. Use recommended solvents and cleaning agents for cleaning tools, equipment and skin.

1.7 ENVIRONMENTAL CONDITIONS

- A. Perform no glazing operations when ambient temperature is at or below 40 deg F (4.4 deg C).

1.8 WARRANTIES

- A. Warrant to begin from the date of substantial completion and include material and labor.
- B. Tempered Glass: Warrant for 10 years from date of acceptance of Project to be free from delamination and discoloration.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Glass Manufacturers: AGC Glass, PPG, LOF, Guardian Industries, Ford Glass, Hordis Brothers Inc., or equal.

2.2 MATERIALS

- A. Components:
 1. Glazing: 1/2 inch thick fully laminated clear glass panels conforming to the specifications of ANSI Z97.1, ASTM C 1048-97b and CPSC 16CFR 1201.
 2. Posts: 8' high, 6"x3"x5/16" HSS post with welded top plate caps and embedded in concrete as per Drawings.
 3. Clamps: 2 1/4"x 2 1/2" x 1/4" mounting clamps secured with a 5/16" hex socket head cap screws.
 4. Stainless Steel Components: Conforming to ASCE 8-02, Specification for the Design of Cold-Formed Stainless Steel Structural Members.
 5. Glass Components: Conforming to GANA Glazing Manual, Tempered Glass Engineering Standards Manual and Laminated Glazing Reference Manual.
 6. Glazing Materials and Accessories: Glazing materials and accessories shall be fully compatible with the materials and finishes with which they are in contact. Neoprene and EPDM materials shall not come in contact with silicone sealant materials.
 - a. Glazing Tapes: Preformed, preshimmed polyisobutylene-butyl tape, 1/2 inch wide x thickness to suit proper face clearance of glass, grey color; "Pecora BB-50 Extru-Seal", PTI "606", Tremco Preshimmed #440, or "Polyshim" ("Polyshim" only where glass lites exceed 150 united inches), or equal.
 7. Anchors and Fasteners: Manufacturer's standard concealed anchors and fastenings. Do not use exposed fasteners.

2.3 FABRICATION

- A. Cut glass to full fit and play, consistent with glass and glazing material manufacturers' recommendations and the requirements of the Drawings.
- B. Follow glass manufacturer's recommendations for minimum bite and edge and face clearances.
- C. Cut lights to smooth straight edges, clean, free of nicks and flares; nipping not permitted.
- D. Glass edges are to be flat and polished.
- E. Tempered and heat strengthened glass shall be horizontally treated only. Fabrication and treatment shall, where at all possible, be such that roller distortion lines (where they may occur) will run horizontally (parallel to sill and head) after installation.
- F. Glass Identification:

1. Tempered and heat strengthened glass shall bear the manufacturer's identification as to type and thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect surfaces to receive glazing materials and report defects which might adversely affect the glazing work. Commencing work implies acceptance of surfaces as satisfactory.
- B. Surfaces shall be free of condensation and moisture.
- C. Steel surfaces shall be primed and dry.

3.2 PREPARATION

- A. Clean rebates and glazing reveals free of foreign matter, special coatings, dust, grease, projections and irregularities prior to setting glass. Solvents used for cleaning shall not etch or damage glass or metal surfaces.
- B. Wipe glass free of dust and oil.

3.3 INSTALLATION

- A. Handle lites so as to prevent nicks and flares on glass edges.
- B. Provide permanently mounted edge blocks at head and jambs of dry-glazed lights to prevent damage to glass edges during installation and lateral shifting of glass due to thermal and seismic loads and vibrations.
- C. Set glass to maintain bite, edge and face clearance stipulated by the glass manufacturer.
- D. Glass hardware clamps to be installed per manufacture's recommendations.

3.4 PROTECTION

- A. Institute protective measures required throughout the remainder of the construction period to ensure that all the materials do not incur any damaged or deterioration.
- B. Identification or caution markers shall not be applied to glass surfaces nor shall they be applied to metal surfaces in any way which would damage or stain the metal.
- C. Replace glass broken or damaged prior to acceptance of Project.

END OF SECTION 08900

SECTION 08901 – GLAZED CURTAIN WALL - (ALTERNATIVE FULL HEIGHT)

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Documents:
 - 1. Drawings and general provisions of the Subcontract apply to this Section.
 - 2. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- B. Section Includes:
 - 1. Full height glass wall.
- C. Glass and glazing is specified with the following components. Unless otherwise noted, glass and glazing specified elsewhere shall conform to materials and glazing requirements and procedures specified in this Section.

1.2 REFERENCES

- A. "Safety Standard for Architectural Glazing Materials (16 CFR 1201) CI and CII issued by the Consumer Product Safety Commission.
- B. ANSI Z 97.1, "Safety Glass Test Requirements".
- C. ASTM International.
 - 1. ASTM C864 Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
 - 2. ASTM C1048 Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass
 - 3. ASTM A 6 Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.

1.3 SYSTEM DESCRIPTION

- A. Install each piece of glass watertight and airtight. Each installation shall withstand local, normal temperature changes, wind loading, impact loading without failure of any kind, including loss or breakage of glass, failure of sealants or gaskets to remain watertight, deterioration of glazing materials, and other defects of work.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's product data, material safety data sheets, and specifications for installations indicated, listing specific materials proposed. Show that products supplied meet or exceed the specified requirements. Indicate completely,

recommendations for use of primers, joint preparation and sealant dimensions, and shall state shelf life for the material.

- B. Shop Drawings: Submit dimensioned drawings of glass wall assemblies including, but not limiting:
 - 1. Plans, elevations and details of product showing component dimensions; framed opening requirements, dimensions, tolerances, and attachment to structure and adjacent materials and assemblies.
- C. Certifications:
 - 1. Certification that all sealants are fully compatible with the surfaces and finishes with which they are in contact.

1.5 QUALITY ASSURANCE

- A. Safety glass standard: Provide tempered glass components that comply with ANSI Z97.1 and testing requirements of CPSC 16 CFR 1201 Category II.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Package and deliver glass in manufacturer's sealed unopened containers, fully identified, and each pane clearly labeled with manufacturer's name and product designation.
- B. Protect glass from damage and store in accordance with manufacturer's recommendations. Keep handling to a minimum. Protect edges of laminated and insulated glass from damage.
- C. Glazing Sealants:
 - 1. Deliver sealants and related accessories to the job site in factory sealed, unopened containers bearing manufacturer's name, product designation and batch number.
 - 2. Store in unopened containers. Follow manufacturer's recommendations for storage temperatures and shelf life (see "Submittals" above).
 - 3. Follow manufacturer's recommendations for handling products containing toxic materials. Keep flammable material away from heat, sparks and open flame. Use recommended solvents and cleaning agents for cleaning tools, equipment and skin.

1.7 ENVIRONMENTAL CONDITIONS

- A. Perform no glazing operations when ambient temperature is at or below 40 deg F (4.4 deg C).

1.8 WARRANTIES

- A. Warrant to begin from the date of substantial completion and include material and labor.
- B. Tempered Glass: Warrant for 10 years from date of acceptance of Project to be free from delamination and discoloration.

- C. Glazing Sealant: Warrant for 10 years per sealant manufacturer's warranty of merchantable quality. Warranty shall certify that cured sealants:
1. Will perform as a watertight weatherseal.
 2. Will not become brittle or crack due to weathering or normal expansion and contraction of adjacent surfaces.
 3. Will not harden beyond a Shore A durometer of 50, nor soften below a durometer of 10.
 4. Will not change color when used with compatible back-up materials.
 5. Will not bleed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Glass Manufacturers: AGC Glass, PPG, LOF, Guardian Industries, Ford Glass, Hordis Brothers Inc., or equal.

2.2 MATERIALS

- A. Components:
1. Glazing: 1/2 inch thick fully laminated clear glass panels conforming to the specifications of ANSI Z97.1, ASTM C 1048-97b and CPSC 16CFR 1201.
 2. 2 1/2" x 6 1/4" engineered anodized aluminum curtain wall system, anodic coating, 0.7 mil minimum thickness.
 3. Glass Components: Conforming to GANA Glazing Manual, Tempered Glass Engineering Standards Manual and Laminated Glazing Reference Manual.
 4. Glazing Materials and Accessories: Glazing materials and accessories shall be fully compatible with the materials and finishes with which they are in contact. Neoprene and EPDM materials shall not come in contact with silicone sealant materials.
 - a. Glazing Tapes: Structural closed cell, double sided acrylic foam glazing tape required for application of interface to the insulating glass unit. (3m VHB B23F or G23F, Norton V2108 DSA glazing tape with 2-part structural silicone).
 - b. Glazing Sealants: One component, silicone based sealant, black color; Dow-Corning "795" or General Electric "Silpruf 2000", or equal.
 - c. Glazing Sealants (Butt Glazing): One component, silicone based sealant, grey color except clear color at butt glazing; Dow-Corning "795" or "999-A", or General Electric "Gesil N 2600", "SCS 100" or "SCS 1200", or equal, as per manufacturer's recommendations for the particular condition of use.
 - d. Primers (If Required For Sealants): Non-staining and non-etching type as recommended by sealant manufacturer.
 5. Anchors and Fasteners: Manufacturer's standard concealed anchors and fastenings. Do not use exposed fasteners.

2.3 FABRICATION

- A. Cut glass to full fit and play, consistent with glass and glazing material manufacturers' recommendations and the requirements of the Drawings.
- B. Follow glass manufacturer's recommendations for minimum bite and edge and face clearances.
- C. Cut lights to smooth straight edges, clean, free of nicks and flares; nipping not permitted.
- D. Glass edges are to be flat and polished.
- E. Tempered and heat strengthened glass shall be horizontally treated only. Fabrication and treatment shall, where at all possible, be such that roller distortion lines (where they may occur) will run horizontally (parallel to sill and head) after installation.
- F. Glass Identification:
 - 1. Tempered and heat strengthened glass shall bear the manufacturer's identification as to type and thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect surfaces to receive glazing materials and report defects which might adversely affect the glazing work. Commencing work implies acceptance of surfaces as satisfactory.
- B. Surfaces shall be free of condensation and moisture.
- C. Steel surfaces shall be primed and dry.

3.2 PREPARATION

- A. Clean rebates and glazing reveals free of foreign matter, special coatings, dust, grease, projections and irregularities prior to setting glass. Solvents used for cleaning shall not etch or damage glass or metal surfaces.
- B. Wipe glass free of dust and oil.

3.3 INSTALLATION

- A. Handle lites so as to prevent nicks and flares on glass edges.
- B. Provide permanently mounted edge blocks at head and jambs of dry-glazed lights to prevent damage to glass edges during installation and lateral shifting of glass due to thermal and seismic loads and vibrations.
- C. Set glass to maintain bite, edge and face clearance stipulated by the glass manufacturer.

D. Full Height Glazing:

1. Where butted glass without mullions is required, seal with silicone sealant in strict accord with sealant and glass manufacturer's directions. Set glass so that joint is plumb and glass edges are aligned to provide for a uniform joint width of 1/4" (3/8" max.). Mask edges of glass to confine sealant to joints and to avoid contact with either face. Use primers where so required. Neatly tool joints to slightly concave surface. Remove masking from glass and clean glass surfaces completely free of sealant material.

3.4 PROTECTION

- A. Institute protective measures required throughout the remainder of the construction period to ensure that all the materials do not incur any damaged or deterioration.
- B. Identification or caution markers shall not be applied to glass surfaces nor shall they be applied to metal surfaces in any way which would damage or stain the metal.
- C. Replace glass broken or damaged prior to acceptance of Project.

END OF SECTION 08900

INTENTIONALLY LEFT BLANK

SECTION 09300 - TILE

PART 1 PRODUCTS

1.1 SECTION INCLUDES

- A. Tile and Accessories:
 - 1. Wall Tile.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI A108/A118/A136.1 - Specifications for the Installation of Ceramic Tile.
 - 2. ANSI A137.1 - Specifications for Ceramic Tile.
- B. Tile Council of North America (TCNA): TCA Handbook for Ceramic Tile Installation, 2007.

1.3 SUBMITTALS

- A. Obtain approvals of submittals prior to delivering products to the jobsite.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Color: White

1.4 QUALITY ASSURANCE

- A. General: Provide tile that complies with ANSI A137.1 where applicable for types, compositions and other characteristics indicated. Provide tile of the color and pattern in the locations indicated on the Drawings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in manufacturer's unopened packaging until ready for installation.
- B. Protect setting materials from freezing or overheating in accordance with manufacturer's instructions.
- C. Store tile and setting materials on elevated platforms, under cover and in a dry location and protect from contamination, dampness, freezing or overheating.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not install adhesives in an unventilated environment.
- B. Maintain ambient and substrate temperature of 50 degrees F (10 degrees C) during tiling and for a minimum of 7 days after completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. American Olean Tile Co.
 - 2. Daltile Corporation
 - 3. or equal.

2.2 TILE

- A. Wall Tile:
 - 1. Series:
 - a. Wall Tile Size: 6 by 6 inches.
 - b. Moisture Absorption: Less than 20 percent.
 - c. Surface Finishes: Plain, White

2.3 TILE SETTING MATERIALS

- A. Tile Setting Materials: Comply with ANSI A108/A118/A136.1 as applicable to the installation methods referenced in Part 3 of this Section.
- B. Silicone Sealant: Silicone sealant, moisture and mildew resistant type, white.
- C. Patching and Leveling Compound: As recommended by tile manufacturer and compatible with both substrate and setting materials.
- D. Membrane at Walls: Polyethylene film, ASTM D 4397, 4.0 mil thickness.
- E. Cementitious Backer Board: High density, cementitious, glass fiber reinforced with 2 inch wide coated glass fiber tape for joints and corners:
 - 1. Thickness: 5/8 inch (16 mm).

PART 3 EXECUTION

3.1 EXAMINATION

- A. Acceptability of Surfaces: Inspect surfaces to be tiled to ensure proper bonding can be achieved, and to verify that surfaces are free of curing membranes, oil, grease, wax and dust.
- B. Substrate Tolerances: Before tiling, inspect surfaces to be tiled to verify that the following tolerances are not exceeded. If tolerances are exceeded, provide specified leveling coat to achieve specified tolerances.
 - 1. Walls: 1/8 inch in 8 feet for dry-set mortar, epoxy and organic adhesives.

3.2 PREPARATION

- A. Layout: Determine locations of control and expansion joints before starting tile work.

Layout tile work in a grid pattern to minimize cuts less than one-half tile in size.

3.3 INSTALLATION

- A. General: Comply with ANSI A108/A118/A136.1 and manufacturer's recommendations. Comply with applicable TCA Handbook for Tile Installation requirements as listed below.

3.4 CLEANING AND PROTECTION

- A. Cleaning: Clean tile within time period recommended by manufacturer, using materials recommended by manufacturer.
- B. Protection: Prohibit foot and wheeled traffic from floors for a minimum of 3 days. Where traffic is unavoidable, provide large flat boards in walkways and wheelways for a minimum of 7 days after installation. Protect from construction dirt and debris with heavy-duty, non-staining construction paper, masked in place.

END OF SECTION 09300

INTENTIONALLY LEFT BLANK

SECTION 09670 – FLUID APPLIED FLOOR FINISH

GENERAL

1.1 SECTION INCLUDES

- A. Labor, products, equipment and services necessary for resinous flooring Work in accordance with the Contract Drawings covering the following components:
 - .1 Fluid applied seamless flooring.
 - .2 Joint, edge, and termination strips..
 - .3 Prior to installation of structural floor slab, advise General Contractor, in writing, of all requirements of concrete substrate regarding finish, level tolerance, and curing.
 - .4 Accessories necessary for complete installation.

1.2 REFERENCES

- A. ASTM C579, Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- B. ASTM D2240, Standard Test Method for Rubber Property—Durometer Hardness.
- C. ASTM D2369, Standard Test Method for Volatile Content of Coatings.
- D. ASTM D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
- E. ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- F. For additional standards please refer to Product Data Sheets

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including physical properties and colors available.
- B. Manufacturer's Safety Data Sheet for each product being used.
- C. Product Samples: Submit Architectural Standard samples representative of the final finish, as applied. The Standard shall be approved in writing by the Architect and shall be the final standard of acceptance of the finish.
- D. Maintenance Instructions: Submit manufacturer's maintenance instructions.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications:
 - .1 Pre-Qualification: Each bidder for this project shall be pre-qualified and approved in writing by the material manufacturer.

- .2 Applicator Experience: Each bidder must have a minimum 5 years experience in the application of the type of system specified. Contractor shall submit a list of five projects of similar size, scope and complexity.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:

- .1 Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name, manufacturer, batch or lot number, and date of manufacture.
- .2 Material should be delivered to job site and checked for completeness and shipping damage prior to job start.

B. Storage:

- .1 Store materials in accordance with manufacturer's written instructions.
- .2 Keep containers sealed until ready for use. Material should be stored in a dry, enclosed, protected area from the elements.
- .3 Do not subject material to excessive heat or freezing.
- .4 Shelf life: Established based on manufacturer's written recommendation for each material being used.

C. Handling: Protect materials during handling and application to prevent damage or contamination.

D. Condition materials for use accordingly to manufacturer's written instructions prior to application.

E. Record material lot number and quantity delivered to jobsite/storage.

1.6 SITE CONDITIONS

A. Do not install the Work of this Section outside of the following environmental ranges with Manufacturers' written acceptance:

- .1 Material Temperature: Precondition material for at least 24 hours between 65° to 75°F (18° to 24°C)
- .2 Ambient Temperature: Minimum/Maximum 50°/85°F (10°/30°C)
- .3 Substrate Temperature: Minimum/Maximum 50°/85°F (10°/30°C). Substrate temperature must be at least 5°F (3°C) above measured Dew Point.
- .4 Mixing and Application attempted at Material, Ambient and/or Substrate Temperature conditions less than 65°F (18°C) will result in a decrease in product workability and slower cure rates.
- .5 Relative Ambient Humidity: Minimum ambient humidity 30%, maximum ambient humidity 75% (during application and curing)
- .6 Measure and confirm Substrate Moisture Content, Ambient Relative Humidity, Ambient and Surface Temperature and Dew Point.

- B. Substrate moisture:
 - .1 Moisture content of concrete substrate must be $\leq 4\%$ by mass as measured with a Tramex[®] CME/CMExpert type concrete moisture meter.
 - .2 Additionally, relative humidity tests may be conducted per ASTM F2170 and values must be $\leq 85\%$.
 - .3 If moisture content of concrete substrate is $> 4\%$ by mass as measured with Tramex[®] CME/CMExpert type and/or if relative humidity tests per ASTM F2170 exceed values $> 85\%$, consider moisture mitigation systems or moisture tolerant primer.
- C. Utilities, including electric, water, HVAC and permanent lighting to be supplied by General Contractor
- D. Maintain constant ambient room temperature of plus or minus 15°F (plus or minus 7°C) with a minimum temperature of 50°F (10°C) and maximum temperature of 85°F (30°C). Maintain constant ambient room temperature for 48 hours before, during and after installation, or until cured. Do not apply while ambient and temperatures are rising.
- E. Erect suitable barriers and post legible signs at points of entry to prevent traffic and trades from entering the work area during application and cure period of the floor.
- F. Protection of finished floor from damage by subsequent trades shall be the responsibility of the General Contractor.
- G. Insure adequate ventilation and air flow.

1.7 WARRANTY

- A. Manufacturer's warranty covering the resinous flooring against defects in materials for one year from date of installation.

Part 2 Products

2.1 MANUFACTURER

- A. Manufacturer shall be certified under ISO 9001: 2008 All liquid materials, including primers, resins, curing agents, finish coats, and sealants are manufactured and tested under an ISO 9001:2008 registered quality system.

2.2 SYSTEM

- A. Cove base: Epoxy mortar 1" cove based.

Part 3 Execution

3.1 EXAMINATION

- A. Examine surfaces to receive flooring system. Notify Architect/General Contractor/Owner/Owner's representative if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected. Do not apply to substrate treatments for moisture, repair, or leveling not of the same Manufacturer.
- B. Surface must be clean, sound and dry. Remove dust, laitance, grease, curing compounds bond inhibiting impregnations, waxes and any other contaminants. All projections, rough spots, etc. should be dressed off to achieve a level surface prior to the application.
- C. Concrete substrate to have a minimum compressive strength of 3,500 psi (24 MPa) at 28 days and a minimum of 215 psi (1.5 MPa) in tension at time of application.
- D. Substrate moisture:
 - .1 Measure and confirm Substrate Moisture Content, Ambient Relative Humidity, Ambient and Surface Temperature and Dew Point.
 - .2 Confirm and record above values at least once every 3 hours during installation, or more frequently whenever conditions change (e.g. Ambient Temperature rise/fall, Relative Humidity increase/decrease, etc.).
- E. Ensure concrete substrate conforms to the minimum requirements of the flooring manufacturer.
- F. Flooring system shall not be applied to sand-cement setting beds. Sand-cement beds shall be removed to structural concrete substrate and re-leveled/sloped as necessary to achieve grade and/or adequate drainage.
- G. Flooring system shall not be applied to asphaltic or bitumen membranes, soft wood, aluminum, copper or fiberglass reinforced polyester/vinyl ester composites.
- H. Application to glazed or vitrified brick and tile, structural wood, steel shall only be permitted with Manufacturer's written recommendation.

3.2 SURFACE PREPARATION

- A. Prepare surface to receive flooring systems in accordance with manufacturer's written instructions.
- B. Remove dirt, oil, grease, wax, laitance, curing compounds, water-soluble concrete hardeners, and other surface contaminants. Remove sealers, finishes, and paints. Remove unsound concrete by appropriate mechanical means.
- C. Concrete: Shall be cleaned and prepared to achieve laitance-free and contaminant-free, open textured surface by shot blasting or equivalent

mechanical means (CSP level as per ICRI guidelines and manufacturer's written recommendation).

- D. Chemical Surface Preparation: Chemical surface preparation (acid etching) is unacceptable and will void Manufacturer's warranty.
- E. Control joints and cracks: Provide repair and treatment of control joints and surface cracks utilizing manufacturer's standard materials and installation details.

3.3 APPLICATION

- A. Mix and apply material with strict adherence to manufacturer's written installation procedures and coverage rates.
- B. Follow Manufacturer's written recommendations on terminations and connections to walls, drains, doorways, columns and floor-to-floor transitions.
- C. Do not apply while ambient and substrate temperatures are rising.
- D. Apply resinous flooring with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform color, sheen and texture, all within limitations of materials and areas concerned.
- E. Match colors and textures of approved samples.
- F. Install cove base 4" high with 1" radius in accordance with manufacturer's written instructions.

3.4 CLEAN UP

- A. Disposal of this product, solution and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.
- B. Empty containers should be taken to an approved waste handling site for recycling or disposal.

3.5 PROTECTION

- A. Freshly applied material should be protected from dampness, condensation and water for at least 72 hrs.
- B. Beware of air flow and changes in air flow. Introduction of dust, debris, and particles, etc. may result in surface imperfections and other defects.
- C. Follow manufacturer's written recommendation with respect to cure, wait time and return to service.

END OF SECTION

SECTION 09911 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on exterior substrates.

1.2 DEFINITIONS

- A. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples: For each type of paint system and each color and gloss of topcoat.

1.4 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. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to:
1. Behr Process Corporation
 2. Benjamin Moore & Co.
 3. Durant Performance Coatings
 4. Sherwin-Williams Company (The).
 5. Tmenec
 6. or equal.

2.2 PAINT, GENERAL

- A. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Colors: Grey, unless otherwise specified.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect & PACE, and leave in an undamaged condition.
- B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

- A. Metal - Structural Iron and Ferrous Steel:
 - 1. Semi-Gloss / Gloss Paint Finish:
 - a. Urethane High Performance (high UV/Abrasion):
 - 1) 2 coats: Grey
- B. Metal - Shop Primed Metal Doors, Trim, Panels and Miscellaneous Surfaces:
 - 1. Semi-Gloss Paint Finish:
 - a. Acrylic High Performance (low UV/Abrasion):
 - 1) 2 coats: Red

END OF SECTION 099113

INTENTIONALLY LEFT BLANK

SECTION 09912 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete masonry units (CMU).
 - 2. Steel.
 - 3. Galvanized metal.
 - 4. Gypsum board.

1.2 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
- D. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
3. VOC content.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Behr Process Corporation.
 2. Benjamin Moore & Co.
 3. Durant Performance Coatings.
 4. Mills Paint.
 5. Sherwin-Williams Company (The).
 6. Tmenec.
 7. or equal.
- B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in other Part 2 articles for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. Colors: White, selected by Architect and Pace from manufacturer's full range.

2.3 PRIMERS/SEALERS

- A. Primer Sealer, Latex, Interior: MPI #50.
- B. Primer, Alkali Resistant, Water Based: MPI #3.

2.4 METAL PRIMERS

- A. Primer, Rust-Inhibitive, Water Based: MPI #107.
- B. Primer, Galvanized, Water Based: MPI #134.

2.5 WATER-BASED PAINTS

- A. Latex, Interior, Semi-Gloss, (Gloss Level 5): MPI #54.
- B. Light Industrial Coating, Interior, Water Based, Semi-Gloss (Gloss Level 5): MPI #153.

2.6 FLOOR COATINGS

- A. Sealer, Water Based, for Concrete Floors: MPI #99.

2.7 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 2. Testing agency will perform tests for compliance with product requirements.
 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Masonry (Clay and CMU): 12 percent.
 - 3. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.
- F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- D. Painting Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in occupied spaces:
 - a. Uninsulated metal piping.
 - b. Pipe hangers and supports.
 - c. Metal conduit.
 - d. Other items as directed by Architect and Pace.
 - 2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Latex System:

- a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
- b. Intermediate Coat: Latex, interior, matching topcoat.
- c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

B. Steel Substrates:

1. Quick-Drying Enamel System:

- a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
- b. Intermediate Coat: Alkyd, quick dry, matching topcoat.
- c. Topcoat: Alkyd, quick dry, semi-gloss (Gloss Level 5), MPI #81.

C. Galvanized-Metal Substrates:

1. Water-Based Light Industrial Coating Over Waterborne Primer System:

- a. Prime Coat: Primer, galvanized, water based, MPI #134.
- b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
- c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5), MPI #153.

D. Gypsum Board Substrates:

1. Latex System:

- a. Prime Coat: Primer sealer, latex, interior, MPI #50.
- b. Intermediate Coat: Latex, interior, matching topcoat.
- c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

E. Cement Board Substrate

1. Latex System:

- a. Prime Coat: Primer sealer, latex, interior, MPI #50.
- b. Intermediate Coat: Latex, interior, matching topcoat.
- c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

END OF SECTION 09912

INTENTIONALLY LEFT BLANK

SECTION 10801 – TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Under lavatory guards.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:
 - 1. Construction details and dimensions.
 - 2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Material and finish descriptions.
 - 4. Features that will be included for Project.
 - 5. Manufacturer's warranty.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of manufacturer warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet accessories to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.7 WARRANTY

- A. Manufacturer's Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within manufacturer's warranty period.

- 1. Warranty Period: 5 years from date of Substantial Completion to include material and labor.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.
- D. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following:
 - 1. A & J Washroom Accessories, Inc.
 - 2. American Specialties, Inc.
 - 3. Bobrick Washroom Equipment, Inc.
 - 4. Bradley Corporation.
 - 5. Tubular Specialties Manufacturing, Inc.
 - 6. or equal.
- B. Toilet Tissue (Jumbo-Roll) Dispenser:

1. Description: Two-roll unit with sliding panel to expose other roll.
2. Mounting: Surface mounted.
3. Capacity: 9-inch diameter rolls.
4. Material and Finish: Stainless steel, No. 4 finish satin.
5. Lockset: Tumbler type.
6. Refill Indicator: Pierced slots at front.

C. Waste Receptacle:

1. Mounting: Wall mounted.
2. Minimum Capacity: 12 gal.
3. Material and Finish: Stainless steel, No. 4 finish satin.
4. Liner: Reusable vinyl liner with tie down cable.

D. Liquid-Soap Dispenser:

1. Description: Designed for dispensing soap in liquid form.
2. Mounting: Vertically oriented, surface mounted.
3. Capacity: 27oz.
4. Materials: Stainless Steel.
5. Lockset: Tumbler type.
6. Refill Indicator: Window type.

E. Grab Bar:

1. Mounting: Flanges with exposed fasteners.
2. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, No. 4 finish (satin).
3. Outside Diameter: 1-1/2 inches.
4. Configuration and Length: As indicated on Drawings.

F. Mirror Unit:

1. Frame: Stainless-steel channel
2. Hangers: Produce rigid, tamper- and theft-resistant installation, using a method as indicated below.
 - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
3. Size: As indicated on drawings.

G. Coat hook

1. Stain stainless steel: Flange 2"x2"

2. Hook: 1"W, 6 ½" H
3. Projects: 31/16
4. Concealed Wall Plate

2.3 UNDERLAVATORY GUARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Plumberex Specialty Products, Inc.
 2. Truebro by IPS Corporation.
 3. or equal.
- B. Under lavatory Guard:
 1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
 2. Material and Finish: Antimicrobial, molded plastic, white.

2.4 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lb, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.

- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 10801

INTENTIONALLY LEFT BLANK

SECTION 10813 - WARM AIR HAND DRYERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Warm-air hand dryers.

1.2 REFERENCES

- A. International Electrotechnical Commission (IEC):
 1. IEC 73/23/CEE – Low Voltage Directive.
 2. IEC 89/336/CEE – Electromagnetic Compatibility (EMC).
 3. IEC 93/68/CEE – CE Marking Directive.
- B. National Fire Protection Association (NFPA):
 1. NFPA 70 – National Electrical Code.
- C. Underwriters Laboratories (UL):
 1. UL 94 - Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
 2. UL 499: Electrical Heating Appliances.
- D. US Federal Government:
 1. U.S. Architectural & Transportation Barriers Compliance Board. Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG).

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of warm air dryer indicated include the following:
 1. Anchoring and mounting requirements.
 2. Material and finish descriptions.
 3. Electrical requirements.
 4. Common characteristics.
 5. Product Test Reports: When requested by Architect provide documentation indicating compliance of products with requirements, from a qualified independent testing agency.
- B. Location Schedule: Indicating model number and installation locations by room number for each warm air dryer required.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample of Standard warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain warm air dryers from a single source from single manufacturer.
- B. Electrical Components: Listed and labeled per NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- C. Quality Standards: Provide warm air dryers complying with the following:
 - 1. UL 499.
 - 2. CSA C22.2 No. 24.
 - 3. IEC 73/23/CEE.
 - 4. IEC 89/336/CEE.
- D. Accessibility Requirements: Comply with requirements of ADA/ABA and with requirements of authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- 1. Deliver warm air dryers in manufacturer's original packaging marked for location of installation.

1.8 WARRANTY

- A. Manufacturer's Warranty: Provide manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship within the following periods following the date of Substantial Completion:
 - 1. Sensors: 1 year.
 - 2. Motor Brushes: 3 years.
 - 3. All Other Components: 10 years.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Basis-of-Design Products: Subject to compliance with requirements, provide commercial toilet accessories manufactured
- B. MATERIALS
 - 1. Aluminum Sheet: ASTM B 209.
 - 2. Stainless Steel Sheet: ASTM A 666, Type 304.
 - 3. Cast Iron: ASTM A 48/A 48M.
 - 4. Steel Sheet: ASTM A 1008, Designation CS.
 - 5. Galvanized Steel Sheet: ASTM A 653, with G60 hot-dip zinc coating.
 - 6. Galvanized Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication.

7. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
8. ABS Plastic: Acrylonitrile-butadiene-styrene resin.
9. Exposed Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-resistant.
10. Concealed Fasteners: Screws, bolts, and other devices compatible with adjacent materials, and of corrosion-resistant material.

2.2 WARM AIR HAND DRYERS

- A. Surface-Mounted, sensor-operated, ADA/ABA, adjustable speed warm air hand dryer.
 1. Cover: Antimicrobial technology, fixed to base plate with two tamper-resistant lock screws, of the following material:
 - a. Aluminum, 1/16 inch (1.5 mm) thick, with white epoxy finish.
 2. Discharge Outlet: Bottom outlet, fixed.
 3. Base: aluminum base with noise dampening blocks.
 4. Operation: Infrared electronic-sensor activated, with automatic power cut-off switch for detection.
 5. Safety Features:
 - a. Automatic cutoff after 30 seconds.
 - b. Self-resetting thermal cut-off.
 6. Operational Characteristics:
 - a. Discharge Temperature: Adjustable from 110 to 140 deg F (43 to 60 deg C) at 4 inches (102 mm) distance.
 - b. Air Speed: 23,000 lfm
 - c. Effective Airflow: Adjustable from 78 to 100 cfm.
 - d. Average Drying Time Range: 10 to 12 seconds.
 - e. Noise Level: 93 dB with hands in air stream.
 7. Electrical Power Characteristics:
 - a. Heating Element: 400 W.
 - b. Motor: Adjustable speed, 400 - 1200 W, 60 Hz, 100 - 120 V.
- B. Special Tools: Provide special tool for removing warm air dryers for internal access for servicing and adjusting.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install warm air dryers in locations indicated, in accordance with manufacturer's written instructions, using recommended fasteners. Install units level, plumb, and firmly anchored in locations and at heights indicated.

3.2 ADJUSTMENT

- A. Adjust variable speed dryers as directed. Instruct Owner's personnel in operations to adjust variable speed dryers.

3.3 FINAL CLEANING

- A. Clean warm air dryer surfaces of handprints and finger marks.

END OF SECTION

SECTION 10820 – TREILLAGE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Trellis panels and accessories.

1.02 REFERENCES:

- A. ASTM A500 – Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- B. ASTM A82 – Mechanical, Physical and Performance Properties of Carbon Steel Wire
- C. ASTM A641 – Zinc-Coated (Galvanized) Carbon Steel Wire
- D. RAL – German Institute for Quality Assurance and Indication.

1.03 QUALITY ASSURANCE

- A. Manufacturer: Minimum 5 years experience manufacturing and supplying trellis structures of the type required for this project.

1.04 SUBMITTALS

- A. Product Data of product specified.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials from damage. Store panels flat. Provide edge protection when strapping is used. Do not apply loads to panel edges.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Manufacturers: Subject to compliance with requirements, provide products including, but not limited to, one of the following:
 - 1. GREENscreen
 - 2. or equal.

2.02 PANELS

- A. Panels shall be rigid, three-dimensional welded wire grid fabricated of 14-gage ASTM A641 galvanized steel wire.
- B. Face Grid: Wires shall be welded at each intersection to form a 2 x 2 inch face grid on the front and back of panels,
- C. Trusses: Face grids shall be separated by bent wire trusses spaced at 2-inch centers and welded to front and back face grids at each truss apex.
- D. Thickness: 3 inches.
- E. Length and Width: Provide in 2-inch nominal increments.
- F. Tolerance: 1/8 inch in width and ¼ inch in length.

2.03 ACCESSORIES

- A. Clips and Straps: Provide manufacturer's standard types of clips and straps suitable for mounting conditions. Fabricate from ASTM A879 galvanized steel. Adjustable clips shall have ¼ inch diameter 18-8 stainless steel bolt, washer, and nut.
- B. Plastic Spacers: Provide ½ inch thick black Ultra High Molecular Weight polyethylene (UHMW) washers to hold clips away from mounting surface.
- C. Fasteners for Attachment to Structure:
 - 1. To Concrete or Masonry: 550 lbs.

2.04 FABRICATION

- A. Cut to size.

2.05 FINISHES

- A. Metal components (except fasteners) shall be factory finished after fabrication.
- B. Finish System: pretreat with general purpose, alkaline, water based cleaner / degreaser applied at 240 degrees F. prime with zinc-rich epoxy powder coat. Topcoat with polyester or polyester-urethane powder coat.
- C. Salt Spray Resistance: Finish shall remain rust free when tested 1680 hours in accordance with ASTM B117.
- D. Color: Gloss Green.
- E. Touch-Up Paint: Provide high quality, exterior-grade spray paint suitable for conditions of use.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect substrates and conditions affecting work of Section. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install panels plumb and square, centered within area designated for panels, and aligned to maintain modular grid.
- B. Avoid cutting panels in field. Where field cutting is essential, apply touch-up paint to cut edges.
- C. Install securely with fasteners located as shown on Drawings.
- D. Repair bent or damaged panels. If panels cannot be repaired to satisfaction of Pace, remove from jobsite and replace with new panels.

END OF SECTION 10820

INTENTIONALLY LEFT BLANK

SECTION 15010 – GENERAL PROVISIONS FOR MECHANICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. All sections of Divisions 15 and 16 apply to this section.

1.2 SUMMARY

- A. The work under Division 15, Mechanical Work shall include all labor, services, materials and equipment and performance of all work required for the installation of all mechanical work as shown on the Drawings and herein specified in the following Sections.
- B. Should there be any discrepancies or a question of intent, refer the matter to the Architect/Engineer for decision before ordering any equipment or materials or before starting any related work.
- C. Where work connects to that of another trade, or to piping or equipment in place, take measurements in the field to make connecting work come true and line up with the item being connected.
- D. Where work specified under other Divisions of the Specifications connects to equipment which is a part of Division 15, provide proper connection(s) to such equipment.
- E. Minor items and accessories or devices reasonably inferable as necessary, to the complete and proper installation and operation of any system, shall be provided by the Trade Contractor for such system whether or not they are specifically called for by the Specifications or Drawings.

1.3 DEFINITIONS

- A. "Piping" includes, in addition to pipe, all fittings, valves, hangers, and other supports and accessories related to such piping.
- B. "Ductwork" includes, in addition to ducts, all fittings, transitions, dampers, hangers and other supports and accessories related to such ductwork.
- C. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, in crawl spaces or buried.
- D. "Exposed" means not installed underground or "concealed" as defined above.
- E. "Invert Elevations" means the elevation of the inside bottom of pipe or duct.
- F. "Mechanical Work" is all of the work in Division 15.

1.4 SUBMITTALS – NOT APPLICABLE

1.5 QUALITY ASSURANCE

- A. Each major component of equipment to have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place.
- B. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.
- C. All equipment provided under Division 15 to perform with the least possible noise and vibration consistent with its duty. Quietness of operation of all equipment is a requirement. Any equipment, as determined by the Owner's Representative, Architect/Engineer or School Principal to be producing objectionable noise or transmitting noise or vibration to the building to be repaired or removed and replaced.
- D. All workmanship shall be first class in every respect and shall be performed only by skilled mechanics.
- E. Notify Architect of broken or open pipes discovered during construction.
- F. Layout and establish the lines and levels necessary for work.
- G. The following Standards shall be used where referenced by the following abbreviations:

- 1. AABC: Associated Air Balance Council
- 2. ADC: Air Diffusion Council
- 3. AIA: American Institute of Architects
- 4. AMCA: Air Moving and Conditioning Association
- 5. ANSI: American National Standards Institute
- 6. ARI: Air Conditioning and Refrigeration Institute
- 7. ASE: Association of Safety Engineers
- 8. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers
- 9. ASME: American Society of Mechanical Engineers
- 10. ASPE: American Society of Plumbing Engineers
- 11. ASTM: American Society of Testing and Materials
- 12. AWPB: American Wood Preserves Bureau
- 13. AWS: American Welding Society
- 14. AWWA: American Water Works Association
- 15. CSA: Canadian Standards Association
- 16. CISPI: Cast Iron Soil Pipe Institute
- 17. EIA: Electronic Industries Association
- 18. EPA: Environmental Protection Agency
- 19. FDA: Food and Drug Administration
- 20. FM: Factory Mutual Insurance Association
- 21. HIS: Hydraulic Institute Standards
- 22. IRI: Industrial Risk Insurers
- 23. IBR: Institute of Boiler and Radiator Manufacturers
- 24. IEEE: Institute of Electrical and Electronics Engineers
- 25. MCAA: Mechanical Contractors' Association of America
- 26. NIST: National Institute of Standards and Testing
- 27. NEBB: National Environmental Balancing Bureau
- 28. NEC: National Electric Code
- 29. NECA: National Electric Contractors Association
- 30. NEMA: National Electrical Manufacturers Association
- 31. NFPA: National Fire Protection Association
- 32. NSC: National Safety Council

- 33. NSF: National Sanitation Foundation
- 34. OSHA: Occupational Safety & Health Administration
- 35. SAE: Society of Automotive Engineers
- 36. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
- 37. TIMA: Thermal Insulation Manufacturers Association
- 38. UL: Underwriters' Laboratories
- 39. USDA: United States Department of Agriculture

H. Drawings:

- 1. The Drawings are essentially diagrammatic in nature and show general arrangement of the equipment, piping, ductwork, accessories, etc. Because of the small scale of the Drawings, it is not possible to show each offsets, fittings, and accessories, which may be required. Carefully investigate the structural conditions, Architectural Drawings, Equipment Drawings, and the finished conditions of the work and arrange such work accordingly, furnish any fittings, pipe accessories that may be required to meet such conditions.
- 2. Any changes from the plans necessary to make the work conform to building as constructed and to fit work of other trades, or to conform to rules of the governing authorities and regulations, shall be met without extra cost to the Owner.
- 3. The layout of the piping, ductwork, equipment, etc., as shown on the Drawings shall be checked and exact locations shall be determined by the dimensions of equipment approved and Contractor shall obtain the Architect's approval for revised layout before the apparatus is installed. Consult the Architectural, Structural, and Equipment Drawings for the dimensions, locations of partitions, locations and sizes of structural supports, foundations, etc.
- 4. Refer to the Architectural Plans for details and large scale Drawings and to approved Shop Drawing of equipment furnished under other Contracts or Sections of the Specifications for exact location of service connections. The equipment Shop Drawings will be furnished to the Contractor before roughing in. Contractor shall not install any piping or ductwork for said equipment until they have received approved Coordination Drawings for same.

I. Minor Deviations:

- 1. The dimensions of equipment hereinafter specified or indicated on the Drawings are intended to establish the outlines and characteristics of such equipment in general. Minor deviations in dimensions will be permitted to allow the manufacturers specified to bid on their nearest stock equipment, provided the specified ratings are met or exceeded.
- 2. Where manufacturers' catalog numbers or types are mentioned in the Specifications or indicated on the Drawings, they are intended to be used as a guide only and shall not be interpreted as taking precedence over the basic rating and duty specified. In all cases, manufacturers shall verify the duty specified with particular characteristics of the equipment they intend to offer for approval and shall also pay the additional charges as may be required under other Divisions.

J. Interferences:

- 1. Before making any installation, the work of the trades must be coordinated and the necessary changes shall be made to avoid interferences or improper effect on work to be performed by any other Section. In the event that interferences develop, the Architect's decision will be final and no additional compensation will be allowed for moving of misplaced piping, ducts, conduit and/or equipment.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Unless otherwise specified, all material and equipment incorporated in the work under the contract shall be new.
- B. Material and equipment specified by one or more manufacturer's name, trade name and/or model number does not limit a bidder from bidding on other equipment providing the procedure set forth in Pace's contract requirements is followed.
- C. The various mechanical systems have been engineered and designed on equipment name and catalog numbers specified or designated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Each Trade Contractor shall be responsible for all of his work fitting into place in a satisfactory and neat workmanlike manner acceptable to the Architect/Engineer.
- B. Confer with other Trade Contractors regarding the location and size of pipes, equipment, fixtures, conduit, ducts, openings, switches, outlets, etc., in order that there may be no interference between the installation of the progress of the work of any Trade Contractor on the project. The Architectural Drawings, showing exact locations or elevations of such devices shall take precedence over the Mechanical and Electrical Drawings.
- C. The Mechanical Drawings are diagrammatic and shall be followed as closely as actual construction of the building and the work of other trade contractors will permit. All changes from Drawings necessary to make the work of each Contractor conform to the building construction and the work of other trade contractors shall be done at the appropriate Trade Contractor's expense.
- D. Unless explicitly stated to the contrary, each Trade Contractor shall furnish and install each item of equipment or material hereinafter specified, complete with all necessary fittings, supports, trim, piping, insulation, etc., as required for a complete and operating installation.
- E. All equipment and materials shall be installed according to the manufacturer's instructions unless otherwise specifically directed by the Trade Contract Documents. All piping, valves, connections, and other like items recommended by the manufacturer or required for proper operation shall be provided without additional cost to the Board.
- F. All references to Contractors in Specifications and Drawings shall refer to the respective Trade Contractor performing that portion of the work.
- G. In general, all piping, ductwork and similar items shall be installed concealed from view above the ceiling, in partitions, shafts, chases, unless otherwise indicated.
- H. Locations of items not definitely fixed by dimensions are approximate only and exact locations necessary to secure the best conditions and results shall be determined at the site, subject to review.
- I. Where pipes are in partitions, furred out spaces and chases, obtain information as to their exact location and size and install work so as to be entirely concealed in the allotted space. If

conflicts arise making this impossible, obtain instructions from the Architect/Engineer before proceeding with the work.

- J. Wherever two or more pipes are to be installed in parallel, or parallel to the piping of other trades, the piping shall be installed with sufficient space between pipes to allow for the proper application of pipe covering, painting and servicing.
- K. Furnish advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, and also furnish information and shop drawings necessary to permit installation of other work without delay.
- L. Where there is evidence that parts of the Mechanical Work will interfere with other work, assist in working out space conditions and/or the structure, make necessary adjustments to accommodate the work.
- M. Mechanical Work installed before coordinating with other work so as to cause interference with other work shall be changed to correct such condition without additional cost to the Board.
- N. In no case shall any pipe, conduit, duct, or item of equipment be installed where it is supported on or suspended from another pipe, conduit, duct or item of equipment.
- O. Where an item or task is specified to be provided "under this section," it shall be understood that, that item or task is the responsibility of the trade responsible for that section, but the work must be performed by qualified workmen of the appropriate trade.
- P. Accessibility:
 - 1. Install Mechanical work to permit removal (without damage to other parts) of coils, heat exchangers, pumps, fan shafts and wheels, belt guards, sheaves and drives, and other parts requiring periodic replacement or maintenance.
 - 2. Arrange pipes, ducts, and equipment to permit ready access to valves, cocks, traps, starters, motors, dampers, control components, and to clear the openings of swinging and overhead doors and of access panels.
 - 3. Change dimensions of ductwork when required to meet job conditions but maintain the same equivalent cross-sectional area.
 - 4. Provide access panels in equipment, ducts, and like items for inspection of interiors and proper maintenance.

END OF SECTION 15010

INTENTIONALLY LEFT BLANK

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
1. Piping materials and installation instructions common to most piping systems.
 2. Concrete base construction requirements.
 3. Escutcheons.
 4. Dielectric fittings.
 5. Mechanical sleeve seals.
 6. Equipment nameplate data requirements.
 7. Nonshrink grout for equipment installations.
 8. Field-fabricated metal and wood equipment supports.
 9. Installation requirements common to equipment specification sections.
 10. Cutting and patching.
 11. Touchup painting and finishing.
 12. Access Panels
 13. Bearings
 14. Drives
 15. Flashings
 16. Cleaning
- B. Pipe and pipe fitting materials are specified in Division 15 piping system Sections.

1.2 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, crawl spaces, 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 duct shafts.
- 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 rubber materials:
1. BS: Acrylonitrile-butadiene-styrene plastic.
 2. CPVC: Chlorinated polyvinyl chloride plastic.
 3. CR: Chlorosulfonated polyethylene synthetic rubber.
 4. EPDM: Ethylene-propylene-diene terpolymer rubber.
 5. NBR: Acrylonitrile-butadiene rubber.
 6. PE: Polyethylene plastic.

7. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, access panels and identification materials and devices.
- B. Coordination Drawings: For access panel and door locations.
- C. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 2. Planned duct systems layout, including elbow radii and duct accessories.
 3. Clearances for installing and maintaining insulation.
 4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 5. Equipment and accessory service connections and support details.
 6. Exterior wall and foundation penetrations.
 7. Fire-rated wall and floor penetrations.
 8. Sizes and location of required concrete pads and bases.
 9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
 11. Access panel locations in ceilings/walls/floors.

1.4 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
 1. American Society for Testing and Materials
 - a. ASTM A 53-98: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - b. ASTM B 32-96: Specification for Solder Metal
 - c. ASTM B 813-93: Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
 - d. ASTM B 828-98: Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
 - e. ASTM C 1107-97: Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
 - f. ASTM C 1173-97: Specification for Flexible Transition Couplings for Underground Piping Systems
 - g. ASTM D 1785-96b: Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
 - h. ASTM D 2235-96a: Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
 - i. ASTM D 2564-96a: Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
 - j. ASTM D 2672-96a: Specification for Joints for IPS PVC Pipe Using Solvent Cement
 - k. ASTM D 2855-96: Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

- l. ASTM D 3139-98: Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
 - m. ASTM F 402-93: Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoelastic Pipe and Fittings
 - n. ASTM F 493-97: Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
 - o. ASTM F 656-96a: Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
 - 2. American Water Works Association
 - a. AWWA C110-98: Ductile-Iron and Gray-Iron Fittings, 3 In. through 48 In. (76 mm through 1219 mm), for Water and Other Liquids
 - b. AWWA C219-97: Bolted, Sleeve-Type Couplings for Plain-End Pipe
 - 3. American Welding Society
 - a. AWS A5.8-92: Specification for Filler Metals for Brazing and Braze Welding
 - b. AWS D1.1-98: Structural Welding Code--Steel
 - c. AWS D10.12-89: Recommended Practices and Procedures for Welding Low Carbon Steel Pipe
 - d. Brazing Handbook. 1991.
 - 4. ASME International
 - a. ASME B1.20.1-83 (Reaffirmed 1992): Pipe Threads, General Purpose (Inch)
 - b. ASME B16.21-92: Nonmetallic Flat Gaskets for Pipe Flanges
 - c. ASME B18.2.1-96: Square and Hex Bolts and Screws--Inch Series
 - d. ASME B31 Series: Code for Pressure Piping
 - e. 1998 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"
 - 5. Copper Development Association Inc.
 - a. Copper Tube Handbook. 1995.
 - 6. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
 - a. MSS SP-107-91: Transition Union Fittings for Joining Metal and Plastic Products
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- C. 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.
- D. Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate phasing and sequencing of all work with Pace and Engineer.
- B. Coordinate mechanical equipment installation with other building components.
- C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- D. Coordinate installation of required supporting devices and sleeves in poured-in-place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- G. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- H. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.
- I. Coordinate connection of electrical services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Dielectric Unions: No preference.
 - 2. Dielectric Flanges: No preference.
 - 3. Dielectric-Flange Insulating Kits: No preference.
 - 4. Dielectric Couplings: No preference.
 - 5. Dielectric Nipples: No preference.
 - 6. Mechanical Sleeve Seals:

- a. Calpico, Inc.
 - b. Metraflex Co.
 - c. Thunderline/Link-Seal
 - d. or equal.
7. Metal, Flexible Connectors:
- a. Grinnell Corp.; Grinnell Supply Sales Co..
 - b. Mercer Rubber Co.
 - c. Metraflex Co.
 - d. or equal.
8. Rubber, Flexible Connectors:
- a. General Rubber Corp.
 - b. Metraflex Co.
 - c. Red Valve Co., Inc.
 - d. or equal.
9. Grooved Fittings:
- a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. Victaulic Company of America.
 - c. Central Sprinkler
 - d. or equal.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 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 15 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, 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.

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.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- 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. 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.
- 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.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 FLEXIBLE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
 - 1. 2-Inch NPS and Smaller: Threaded.
 - 2. 2-1/2-Inch NPS and Larger: Flanged.
 - 3. Option for 2-1/2-Inch NPS and Larger: Grooved for use with keyed couplings.
- B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
- C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose. Do not use for potable water.

- D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose. Do not use for potable water.
- E. Couplings may be used to provide allowance for controlled pipe movement, expansion, contraction, and or deflection to absorb movement for thermal changes, settling or seismic action and also vibration attenuation.

2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- 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.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Rough brass.
- E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, 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.

2.9 ACCESS PANELS

- A. General: Refer to Division 8 Section, "Access Doors and Frames," for access panel manufacturers and other requirements.

2.10 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 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
 - g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.

- h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas 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 7 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 7 Section "Joint Sealants" for materials and installation.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Verify final equipment locations for roughing-in.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 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. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - 2. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 3. Align threads at point of assembly.
 - 4. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - 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.
- 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: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- 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. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 3. PVC 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 provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install mechanical 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.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.5 PAINTING AND FINISHING

- A. Refer to Division 9 Section "Interior Painting" for paint materials, surface preparation, and application of paint.
- B. Do not paint piping specialties with factory-applied finish.
- C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.

3.7 CLEANING

- A. Coordinate general cleanup with work specified in other specification sections.

3.8 ACCESS PANELS

- A. Where control valves, shut-off valves, drip traps, heating coils, dampers, pull boxes or other specialties, which require service or adjustment, are installed above inaccessible type furred ceilings or within furred walls, the Trade Contractor whose equipment is involved shall furnish and install access panels as required.

- B. Each Trade shall confer with other trades with respect to access panel locations, and shall wherever practical group valves, traps, dampers, etc. in such a way as to be accessible from a single panel and eliminate as many access panels as possible.

3.9 ERECTION

- A. Provide all necessary rigging, scaffolding, tools, tackle, labor and other like items necessary for the complete installation of the equipment.
- B. Adapt work to job conditions and install work to clear beams, joists and light fixtures, adjusting risers, avoiding interferences with windows and openings, raising or lowering work to permit the passing of ductwork or the work of other trades, all as required or as job conditions dictate, without additional costs to Pace.
- C. Trade Contractor shall not rig, tie to, or rest weight upon any part of the building or make use of any stairway until specific permission is obtained.
 - 1. Permission to rig to or make use of any part of the building premises shall not relieve the contractor of responsibility for any damage.
- D. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- E. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.10 FLASHINGS

- A. Openings in roof shall be flashed with 40 lb. sheet lead, in one piece, extending 24" under roofing in all directions from drains, pipes, or ducts, with upper edge at least 8" above the roof and turned over and down into increaser or sleeve or over curb for at least 1" and tightly bound with nonferrous wire.
 - 1. All lead flashings shall be entirely painted with a good coat of black asphaltum before installation.
 - 2. Roof flashing must be approved in writing by the Roofing Trade contractor to the effect that such flashing will not void guarantees or bonds pertaining to the roofing contract.
 - 3. Coordinate with the work under Division 7.

3.11 OPENINGS

- A. Where temporary openings are necessary thru walls and partitions of the building for the entry or installation of tanks, fans, or other machinery or apparatus, or for driveways and other facilities, the permanent work of the mechanical trades at said openings shall be temporarily omitted and installed after equipment is brought into the building or after temporary facilities are removed.
- B. Refer to other Sections of the Specifications for framing of openings for ducts, grilles, registers, etc., in walls, partitions, floors, roofs, etc. The trade for each service shall be responsible for locating and providing the proper dimensions for all required openings.
- C. No cutting or drilling of any building structural members will be permitted, unless the specific extent and limits are approved, in writing, by the Architect.
- D. All openings in the existing structure shall be core drilled with a diamond drill. The use of jackhammers will not be permitted.

- E. The Contractor shall notify the Architect and Pace if any existing openings are uncovered adjacent to location of a new opening. The new opening shall not be drilled if the existing can be used unless directed by the Architect and Pace.

END OF SECTION 15050

INTENTIONALLY LEFT BLANK

SECTION 15060 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. All sections of Divisions 15 and 16 apply to this section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for mechanical 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 positioning systems.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Powder-actuated fastener systems.
 - 4. Pipe positioning systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Rooftop Pipe Supports. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel." and ASME Boiler and Pressure Vessel Code: Section IX.

1.6 DELIVERY, STORAGE AND HANDLING – NOT APPLICABLE

1.7 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - a. Steel Pipe Hangers and Supports:
 - 1) Anvil
 - 2) B-Line Systems, Inc.; a division of Cooper Industries.
 - 3) Carpenter & Paterson, Inc.
 - 4) or equal.
 - b. Powder-Actuated Fasteners:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head
 - 3) or equal.
 - c. Mechanical-Expansion Anchors:
 - 1) B-Line Systems, Inc.; a division of Cooper Industries.
 - 2) Hilti, Inc.
 - 3) ITW Ramset/Red Head
 - 4) or equal.
 - d. Thermal-Hanger Shield Inserts:
 - 1) Carpenter & Paterson, Inc.
 - 2) PHS Industries, Inc.
 - 3) Pipe Shields, Inc.
 - 4) or equal.
 - e. Pipe Positioning Systems:
 - 1) C & S Mfg. Corp.
 - 2) HOLDRITE Corp.; Hubbard Enterprises.
 - 3) Samco Stamping, Inc.
 - 4) or equal.

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. Corrosion Protection: Hangers and components shall be galvanized or painted with carbo-zinc #11.
- C. Threads: All threads shall be UNC unless otherwise specified.
- D. Heat Transmission: Supports, guides and anchors shall limit the amount of heat transmitted to the structural steel. Temperature of supporting parts shall be based on a 100°F per inch temperature gradient from the outside pipe surface.

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 FASTENER SYSTEMS

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

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 PIPE POSITIONING SYSTEMS

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

2.7 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. Hangers installed outdoors shall have two coats of rust inhibitor paint after installation and adjustment.
- 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 1/2 to NPS 30.
 - 2. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 3. 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.
 - 4. 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.
- 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.
- 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. 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. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 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. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 9. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 10. 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 (340 kg).
 - b. Medium (MSS Type 32): 1500 lb (680 kg).
 - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
 11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 13. 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. 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 powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- N. 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. Trapeze bars shall be tightly secured to structural members at two points with bolts or other similar mechanical fasteners. Hangers from bar joist and fabricated truss members shall be located at the panel points of the structural members. C-clamp type hangers attached to one side of double-angle bottom members are not allowed. Point loads shall not exceed the lesser of:
 - a. Manufacturer's certified recommendation for the component parts.
 - b. The following maximum point loads, and maximum hanger spacings as herein specified, for structural elements in any direction; except as specifically approved by the Engineer of Record:

Structural Element Type	Maximum Hanger Point Load (lb)
Metal deck without concrete topping	50
Composite metal deck slab with concrete topping	50
Steel Beams:	
All channels WF4 through WF8	100
WF10 through WF14	200
WF16 through WF24	400
WF27 through WF36	750
Built-up structural steel trusses	250
Reinforced post-tensioned concrete elements	
Slabs up to 6" thick	150
Slabs over 6" thick	250
Joists 8" wide	250
Beam/girders 8" wide	500

- 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. Drive screws, pins, studs, etc., of the type which are secured in place by means of explosive force may be used as a means of securing any of the hangers subject to the following:
 - a. The stud, pin or fastener shall be caused to have a velocity not in excess of 300 feet per second when measured 6-1/2 feet from the muzzle of the tool by accepted ballistic test methods.
 - b. Only workmen qualified by instructions of the manufacturers representative and/or licensed by the state and local authorities shall be assigned to use a powder actuated fastening tool.
 - c. Where practical, tools of only one manufacturer shall be used on a project.
 - d. Only cartridges and fasteners supplied by the manufacturer of the tool shall be used to operate that tool.
 - e. Powder actuated fastening tools shall be handled with the same care as firearms.
 - f. All safety devices incorporated in the tool by the manufacturer shall be used at all times.
 - g. Acceptable types of powder actuated fastening tools are:
 - 1) Piston Tool - Low Velocity Type - is a tool utilizing a piston, activated by the power of a blank cartridge furnished by the manufacturer for use with it, to drive a stud, pin or fastener into a work surface.
 - 2) Powder Assisted Hammer Drive Tool - Low Velocity Type - is a tool utilizing a captive piston, activated by a blow from a 4 lb. hammer supplemented by the power of a blank cartridge furnished by the manufacturer for use with the tool, to drive a stud, pin or fastener into a work surface.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 15 Section "Plumbing Fixtures" for plumbing fixtures.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- N. 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.
 - 5. Insert Material: Length at least as long as protective shield.
 - 6. 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. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 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.
 2. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish. Hangers installed outdoors shall have two coats of rust inhibitor paint after installation and adjustment.
 3. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15060

INTENTIONALLY LEFT BLANK

SECTION 15074 - VIBRATION CONTROL FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. All sections of Divisions 15 and 16 apply to this section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Vibration isolation for piping, duct and equipment.

1.3 DEFINITIONS

- A. Not applicable.

1.4 SUBMITTALS

- A. Catalog cutsheets that include rated load, rated deflection, and overload capacity for each vibration isolation device.
- B. Submit details of equipment bases including dimensions, structural member sizes and support point locations.
- C. Submit details of isolation hangers for ceiling hung equipment, piping and ductwork.
- D. Submit details of mountings for floor-supported equipment and piping
- E. All hanger, mounting or pad drawings shall indicate deflections and model numbers as well as any other requirements in the specifications.
- F. Spring diameters, rated loads and deflections, heights at rated load and closed height shall be provided for all springs shown in the submittals in tabular form.
- G. Provide complete flexible connector details.

1.5 QUALITY ASSURANCE

- A. The isolation materials manufacturer shall be responsible for the proper selection of spring rates to accomplish the specified minimum static deflections for all spring and pay type isolators based on the weight distribution of equipment to be isolated.

- B. The isolation materials manufacturer shall be responsible for the structural design of steel beam bases and concrete inertia bases to support mechanical equipment scheduled or specified to receive a supplementary base.
- C. Furnish a complete set of final Shop Drawings of all mechanical equipment to receive vibration isolation devices to the vibration isolation materials manufacturer. These Drawings will be the basis upon which the selection of vibration isolators and design of supplementary bases will be completed. The Shop Drawings to be furnished shall include operating weight of the equipment to be isolated and the distribution of weight to the support points.
- D. Furnish a complete layout of piping and ductwork to be isolated, including vertical risers, showing size or weight and support points of the piping system to the vibration isolation materials manufacturer for selection and layout of isolation hangers.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Store equipment in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide diffusers by one of the following:
 - 1. Mason Industries.
 - 2. Vibration Eliminator Company.
 - 3. Kinetics Noise Control, Inc.
 - 4. Vibration Mountings and Controls, Inc.
 - 5. or equal.

2.2 VIBRATION ISOLATOR SELECTION

- A. Noise and vibration isolator types, minimum operating static deflections, and supplemental bases shall be provided for individual mechanical equipment units according to selection criteria delineated in Table 1 incorporated as part of this specification or as tabulated in the equipment schedules of the project Drawings.
- B. Isolator types are scheduled to establish minimum standards. At the Contractor's option labor saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages, provided isolators supplied incorporate and specified isolator type, and do not degrade the noise and vibration isolation of equipment mounted.
- C. Isolators exposed to the outdoors shall have weather-proof finish on all parts.

2.3 NEOPRENE MOUNTINGS

- A. Neoprene mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on

the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang. Mountings shall be type ND or rails type DNR as manufactured by Mason Industries, Inc.

2.4 SPRING ISOLATORS

- A. General: Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4"(6mm) neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be type SLF, as manufactured by Mason Industries, Inc.

2.5 HANGERS

- A. General: Hangers shall consist of rigid steel frames containing minimum 1-1/4" thick neoprene elements at the top, a steel spring with general characteristics as described in Paragraph 2.4, and shall be seated in a steel washer-reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated. The neoprene element shall not be stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be type 30N as manufactured by Mason Industries, Inc.
- B. Spring Locks: Hangers shall be precompressed and locked at the rated deflection by means of a resilient upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
- C. Hangers shall be manufactured with minimum characteristics as described in Paragraph 2.4, but without the neoprene element. Springs shall be seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod hanger contact. Spring diameters and the lower hole sizes shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing. For ducts suspended by flat strap iron, the hanger assembly shall be modified by the manufacturer with an eye on top of the box and on the bottom of the spring hanger rod to allow for bolting to the hanger straps. Submittals shall include a scale drawing of the hanger showing the 30° capability. Hangers for rods shall be Type 30 or for straps W30 as manufactured by Mason Industries, Inc.

2.6 SPLIT SEALS

- A. Split Seals consist of pipe halves with minimum 3/4" thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures

exceed 240°F, 10 lb. density fiberglass may be used in lieu of the sponge. Seals shall be Type SWS as manufactured by Mason Industries, Inc.

2.7 ACOUSTICAL PIPE ANCHORS

- A. All directional acoustical pipe anchors, consist of two sizes of steel tubing separated by a minimum 1/2" thickness of 60 duro or softer neoprene. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction. All directional anchors shall be type ADA as manufactured by Mason Industries, Inc.

2.8 DUCT ISOLATION

- A. All air ducts with a cross section of 2 square feet or larger shall be isolated from the building structure by hangers as shown in Paragraph 2.5C or floor supports with a minimum deflection of 0.75". Isolators shall continue for 50' from the equipment. If air velocity exceeds 1000 fpm, hangers or supports shall continue for an additional 50' or as shown on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic[- and wind]-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 GENERAL

- A. All vibration isolators must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
- C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building. This includes, but is not limited to, slabs, beams, columns, studs and walls.
- E. Coordinate work with other trades to avoid rigid contact with the building.
- F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers

attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.

- G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractors expense.
- H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractors expense.
- I. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed specified capabilities.
- J. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide seals as described in this specification.
- K. Locate isolation hangers as near to the overhead support structure as possible.

3.3 VIBRATION ISOLATION OF PIPING

- A. Horizontal pipe shall be installed in accordance with 2.15 Horizontal Pipe Isolation.
- B. Risers shall be installed in accordance with 2.16 Riser Isolation.

3.4 VIBRATION ISOLATION OF DUCTWORK

- A. All duct runs shall be installed in accordance with 2.17 Duct Isolation.

3.5 ISOLATOR SCHEDULE

Equipment	<i>Paragraph</i>	<i>Min Static Deflect</i>
Centrifugal Fans Suspended	2.5A, 2.6	1.0

END OF SECTION 15074

INTENTIONALLY LEFT BLANK

SECTION 15082 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. All sections of Divisions 15 and 16 apply to this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Mineral fiber.
 - 2. Insulating cements.
 - 3. Adhesives.
 - 4. Mastics.
 - 5. Factory-applied jackets.
 - 6. Field-applied jackets.
 - 7. Tapes.
 - 8. Securements.

1.3 DEFINITIONS

- A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.
- B. Cold Surfaces: Normal operating temperatures less than 75 deg F.
- C. Thermal Resistivity: "r-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogeneous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.
- D. Density: Is expressed in lb/cu.ft.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, Thermal resistance (R Value), thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 2. Detail attachment and covering of heat tracing inside insulation.
 3. Detail insulation application at pipe expansion joints for each type of insulation.
 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 6. Detail application of field-applied jackets.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Sample Sizes:
 - a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - b. Sheet Form Insulation Materials: 12 inches square.
 - c. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - d. Sheet Jacket Materials: 12 inches square.
 - e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."

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

1.8 SCHEDULING

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

PART 2 - PRODUCTS

A. MANUFACTURERS

1. Subject to compliance with requirements, provide products by one of the following manufacturers:
 - a. Flexible Elastomeric Insulation:
 - 1) Aeroflex USA Inc.; Aerocel.
 - 2) Armacell LLC; AP Armaflex.
 - 3) RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180 or equal.
 - 4) or equal.
 - b. Mineral Fiber Blanket Insulation:
 - 1) CertainTeed Corp.; Duct Wrap.
 - 2) Johns Manville; Microlite.
 - 3) Knauf Insulation; Duct Wrap.
 - 4) Owens Corning; All-Service Duct Wrap or equal.
 - 5) or equal.
 - c. Mineral-Fiber, Preformed Pipe Insulation:
 - 1) Johns Manville; Micro-Lok.
 - 2) Knauf Insulation; 1000(Pipe Insulation.
 - 3) Owens Corning; Fiberglas Pipe Insulation or equal.
 - 4) or equal.
 - d. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1) Insulco, Division of MFS, Inc.; Triple I.
 - 2) P. K. Insulation Mfg. Co., Inc.; Super-Stik
 - 3) or equal.
2. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote
 - b. or equal.
3. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement:
 - a. Insulco, Division of MFS, Inc.; SmoothKote.
 - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
 - c. Rock Wool Manufacturing Company; Delta One Shot
 - d. or equal.
4. Flexible Elastomeric and Polyolefin Adhesive:
 - a. Aeroflex USA Inc.; AeroSeal.
 - b. Armacell LCC; 520 Adhesive.

- c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive
 - e. or equal.
5. Mineral-Fiber Adhesive:
- a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80
 - d. or equal.
6. Mineral-Fiber, Pipe and Tank Insulation:
- a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Owens Corning; Fiberglas Pipe and Tank Insulation
 - e. or equal.
7. Mineral-Fiber Insulating Cement:
- a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik
 - c. or equal.
8. Expanded or Exfoliated Vermiculite Insulating Cement:
- a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote
 - b. or equal.
9. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement:
- a. Insulco, Division of MFS, Inc.; SmoothKote.
 - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
 - c. Rock Wool Manufacturing Company; Delta One Shot
 - d. or equal.
10. Flexible Elastomeric and Polyolefin Adhesive:
- a. Aeroflex USA Inc.; AeroSeal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive
 - e. or equal.
11. Mineral-Fiber Adhesive:
- a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225
 - e. or equal.
12. PVC Jacket Adhesive:
- a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Red Devil, Inc.; Celulon Ultra Clear
 - e. or equal.
13. Vapor-Barrier Mastic:
- a. Childers Products, Division of ITW; CP-35.

- b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. Marathon Industries, Inc.; 590.
 - d. Vimasco Corporation; 749
 - e. or equal.
14. Breather Mastic:
- a. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. Marathon Industries, Inc.; 550.
 - d. Vimasco Corporation; WC-1/WC-5
 - e. or equal.
15. PVDC Jacket for Indoor Applications:
- a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film
 - b. or equal.
16. PVDC-SSL Jacket:
- a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film
 - b. or equal.
17. PVC Jacket:
- a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe
 - e. or equal.
18. Metal Jacket:
- a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate
 - d. or equal.
19. ASJ Tape:
- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ
 - e. or equal.
20. PVC Tape:
- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS
 - e. or equal.
21. Bands:
- a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands
 - d. or equal.
22. Capacitor-Discharge-Weld Pins:

- a. AGM Industries, Inc.; CWP-1.
 - b. GEMCO; CD.
 - c. Midwest Fasteners, Inc.; CD.
 - d. Nelson Stud Welding; TPA, TPC, and TPS
 - e. or equal.
23. Cupped-Head, Capacitor-Discharge-Weld Pins:
- a. AGM Industries, Inc.; CWP-1.
 - b. GEMCO; Cupped Head Weld Pin.
 - c. Midwest Fasteners, Inc.; Cupped Head.
 - d. Nelson Stud Welding; CHP
 - e. or equal.
24. Metal, Adhesively Attached, Perforated-Base Insulation Hangers:
- a. AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - b. GEMCO; Perforated Base.
 - c. Midwest Fasteners, Inc.; Spindle
 - d. or equal.
25. Insulation-Retaining Washers:
- a. AGM Industries, Inc.; RC-150.
 - b. GEMCO; R-150.
 - c. Midwest Fasteners, Inc.; WA-150.
 - d. Nelson Stud Welding; Speed Clips
 - e. or equal.
26. Wire:
- a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.
 - e. or equal.

2.2 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain 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. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Mineral-Fiber, Preformed Pipe Insulation:

1. 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.

2.3 ADHESIVES

- A. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
- B. 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.
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
- F. Mineral-Fiber, Pipe Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 4. Color: White.
 5. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 200 deg F.
 3. Solids Content: 63 percent by volume and 73 percent by weight.
 4. Color: White.

5. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

2.5 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. Adhesive: As recommended by jacket material manufacturer.
 2. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
 3. Color: Color-code jackets based on system.
 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.

2.6 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
 4. Elongation: 500 percent.

5. Tensile Strength: 18 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch wide with wing seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
4. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

- C. Wire: 0.080-inch nickel-copper alloy 0.062-inch soft-annealed, stainless steel 0.062-inch soft-annealed, galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. 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.
- O. 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.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at 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.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or Sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut Sectional pipe insulation to fit. Butt each Section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or Sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or Sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a Section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from Sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from Sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part Section on the vertical center line of valve body.
 - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation Section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut Sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered Sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut Sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed Sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered Sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

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

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. 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.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Underground piping.

3.11 PIPING INSULATION SCHEDULE

- A. General: Abbreviations used in the following schedules include:
1. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.
- B. INTERIOR DOMESTIC HOT WATER AND RECIRCULATED HOT WATER

PIPE SIZES (NPS)	MATERIALS	THERMAL CONDUCTIVITY, K FOR LISTED K	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD-APPLIED JACKET
ALL SIZES	GLASS FIBER	.28	1	NO	(P)
	FLEXIBLE ELASTOMERIC	.26	1	NO	NONE, (P in exposed locations)

NOTE: INCREASE INSULATION THICKNESS 1/2" FOR PIPES > 1-1/2" IN SYSTEMS OPERATING BETWEEN 140F AND 169F. INCREASE INSULATION THICKNESS 1/2" FOR 1-1/2" AND 2" PIPES OPERATING BETWEEN 170F AND 180F. INCREASE INSULATION THICKNESS 1" FOR PIPES > 2" OPERATING BETWEEN 170F AND 180F.

C. INTERIOR DOMESTIC COLD WATER AND STORM DRAINAGE:

PIPE SIZES (NPS)	MATERIALS	THERMAL CONDUCTIVITY, K FOR LISTED K	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD-APPLIED JACKET
1/2 TO <1-1/2	GLASS FIBER	.28	1/2	Yes Factory Installed	(P)
	FLEXIBLE ELASTOMERIC	.26	1/2	NO	NONE, (P in exposed locations)
1-1/2 TO <4	GLASS FIBER	.28	1	Yes Factory Installed	(P)
	FLEXIBLE ELASTOMERIC	.26	1	NO	NONE, (P in exposed locations)

3.12 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. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
 - 1. PVC, Color-Coded by System: 30 mils thick.

END OF SECTION 15082

SECTION 15083 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. All sections of Division 15 and 16 apply to this section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Calcium silicate.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Polyisocyanurate.
 - 2. Fire-rated insulation systems.
 - 3. Insulating cements.
 - 4. Adhesives.
 - 5. Mastics.
 - 6. Lagging adhesives.
 - 7. Sealants.
 - 8. Factory-applied jackets.
 - 9. Field-applied jackets.
 - 10. Tapes.
 - 11. Securements.
 - 12. Corner angles.

1.3 DEFINITIONS

- A. Cold Surfaces: Normal operating temperatures less than 75 deg F.
- B. Thermal Resistivity: "r-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogeneous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.
- C. Density: Is expressed in lb/cu.ft.

1.4 SUBMITTALS

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

- B. Shop Drawings:
 - 1. Ductwork insulation
 - 2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 3. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
 - 1. Sample Sizes:
 - a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - b. Sheet Form Insulation Materials: 12 inches square.
 - c. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - d. Sheet Jacket Materials: 12 inches square.
 - e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Containers for Insulation material, coverings, cements, adhesives and coatings shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, maximum use temperature, and fire hazard index.
- B. Protect against dirt, water and chemical and mechanical damage. Do not install damaged or wet insulation. Remove any such damaged and wet insulation from site.

1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."

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

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Flexible Elastomeric:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180
 - d. or equal.
 - 2. Mineral-Fiber Blanket Insulation:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Owens Corning; All-Service Duct Wrap
 - d. or equal.
 - 3. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating. Products:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
 - d. Thermal Ceramics; FireMaster Duct Wrap.
 - e. 3M; Fire Barrier Wrap Products.
 - f. Unifrax Corporation; FyreWrap.
 - g. Vesuvius; PYROSCAT FP FASTR Duct Wrap
 - h. or equal.
 - 4. Flexible Elastomeric and Polyolefin Adhesive:
 - a. Aeroflex USA Inc.; Aero seal.

- b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive
 - e. or equal.
5. Mineral-Fiber Adhesive:
- a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80
 - d. or equal.
6. ASJ Adhesive, and FSK Adhesive:
- a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80
 - d. or equal.
7. PVC Jacket Adhesive:
- a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. Speedline Corporation; Speedline Vinyl Adhesive
 - d. or equal.
8. Vapor-Barrier Mastic:
- a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Vimasco Corporation; 749
 - e. or equal.
9. Metal Jacket Flashing Sealants:
- a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44..
 - c. Vimasco Corporation; 750
 - d. or equal.
10. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
- a. Childers Products, Division of ITW; CP-76
 - b. or equal.
11. PVC Jacket:
- a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe
 - e. or equal.
12. ASJ Tape:
- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ
 - e. or equal.
13. FSK Tape:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ
 - e. or equal.
14. PVC Tape:
- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS
 - e. or equal.
15. Bands:
- a. PABCO Metals Corporation; Bands.
 - b. RPR Products, Inc.; Bands
 - c. or equal.
16. Insulation Pins and Hangers:
- a. AGM Industries, Inc.; CWP-1.
 - b. GEMCO; Cupped Head Weld Pin.
 - c. Midwest Fasteners, Inc.; Cupped Head.
 - d. Nelson Stud Welding; CHP
 - e. or equal.
17. Wire:
- a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.
 - e. or equal.

2.2 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain 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. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- H. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating. Products:

2.3 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

2.4 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.5 ADHESIVES

- A. All Adhesives & Sealants: All adhesive and sealants installed in the building interior shall meet the testing and product requirements of of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
- B. 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.
- C. Cellular-Glass, Phenolic and Polyisocyanurate, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
- D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

2.6 MASTICS

- A. All Mastics (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
- B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F .
 - 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 4. Color: White.

2.7 SEALANTS

- A. All Adhesives & Sealants : All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
- B. 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.

2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils
 - 3. Adhesion: 90 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils .
 - 3. Adhesion: 90 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils
 - 3. Adhesion: 64 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.020 inch thick, 3/4 inch wide with wing or closed seal..
2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and prepare surfaces to be insulated. Remove materials that will adversely affect insulation application. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

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

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. 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.
- O. 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..

3.4 PENETRATIONS

- A. 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.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

3.5 MINERAL-FIBER INSULATION INSTALLATION

- A. Blanket 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.
6. 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.
7. 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.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.

3.7 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ exposed to view only: Paint jacket with paint system identified below and as specified in Division 9 painting Sections. Coordinate with Architect and Pace.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect and Pace. Vary first and second coats to allow visual inspection of the completed Work.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections..
- B. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect and Pace, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.
 - 2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect and Pace, 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. Architect and Pace may reject all work if sample work is found to be defective.

3.9 DUCT INSULATION PERFORMANCE , GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, outdoor air.
 - 2. Indoor, exhaust between exhaust fan penetrations of building exterior.
- B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1 2004.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. INSULATION APPLICATION SCHEDULE

1. General: Abbreviations used in the following schedules include:
 - a. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.

B. DUCT SYSTEMS INSULATION SCHEDULE

DUCT LOCATION	OUTSIDE AIR, SUPPLY AIR , EXHAUST AIR (DOWN STREAM OF DAMPER) INSULATION INSTALLED R-VALUE (H-FT ² - °F)/BTU	RETURN INSULATION INSTALLED R-VALUE (H- FT ² -°F)/BTU
UNCONDITIONED SPACE (NOTE 1,2,3,4,5)	6.5	6.5

NOTE 1: INSULATION R-VALUES, MEASURED IN (H X FT² X F)/BTU, ARE FOR THE INSULATION AS INSTALLED AND DO NOT INCLUDE FILM RESISTANCE. WHERE EXTERIOR WALLS ARE USED AS PLENUM WALLS, WALL INSULATION SHALL BE AS REQUIRED BY THE MOST RESTRICTIVE CONDITION OF ASHRAE 90.1-2004 SECTION 5 OR 6.4.4.2. INSULATION RESISTANCE MEASURED ON A HORIZONTAL PLANE IN ACCORDANCE WITH ASTM C518 AT A MEAN TEMPERATURE OF 75F AT THE INSTALLED THICKNESS.

NOTE 2: CAVITY CONTAINED WITHIN THE INSULATED BUILDING ENVELOPE.

NOTE 3: VAPOR BARRIER REQUIRED.

NOTE 4: FIELD APPLIED JACKET (PVC FOR INTERIOR EXPOSED LOCATIONS).

NOTE 5: PROVIDE MINERAL FIBER BOARD WITH FIELD APPLIED JACKET) IN EXPOSED LOCATIONS IN LIEU OF MINERAL FIBER BLANKET.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material.
 1. PVC, Color-Coded by System: 20 mils thick.

END OF SECTION 15083

SECTION 15110 - VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. All sections of Division 15 and 16 apply to this section.

1.2 SUMMARY

- A. This Section includes the following general-duty valves:
 - 1. Bronze check valves.
 - 2. Bronze gate valves.
 - 3. Bronze globe valves.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 - 1. CWP: Cold working pressure.
 - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 3. NBR: Acrylonitrile-butadiene rubber.
 - 4. PTFE: Polytetrafluoroethylene plastic.
 - 5. SWP: Steam working pressure.
 - 6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.9 for building services piping valves.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- 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 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 MANUFACTURERS

A. Subject to compliance with requirements, provide valves by one of the following or equal:

B. Bronze ball valves:

1. Conbraco Industries, Inc.; Apollo Div.
2. Crane Co.; Crane Valve Group; Stockham Div.
3. NIBCO INC.
4. Watts Industries, Inc.; Water Products Div.
5. or equal.

C. Bronze check valves:

1. Crane Co.; Crane Valve Group; Stockham Div.
2. Milwaukee Valve Company.
3. NIBCO INC.
4. Watts Industries, Inc.; Water Products Div.
5. or equal.

D. Bronze gate valves:

1. Crane Co.; Crane Valve Group; Stockham Div.
2. Milwaukee Valve Company.
3. NIBCO INC.
4. or equal.

E. Bronze globe valves:

1. Crane Co.; Crane Valve Group; Stockham Div.
2. Milwaukee Valve Company.

3. NIBCO INC.
4. or equal.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
- C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 2. Handwheel: For valves other than quarter-turn types.
 3. Lever Handle: 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 10 plug valves, for each size square plug head.
- G. Valves in insulated piping shall have 2-inch stem extensions and the following features:
 1. Gate valves shall be rising stem type.
 2. Ball valves shall have extended operating handle of no-thermal conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.
- H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- I. Valve Grooved Ends: AWWA C606.
 1. Solder Joint: With sockets according to ASME B16.18.
 - a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
 2. Threads shall be in accordance with ASME B1.20.1.
- J. Valve bypass and drain connections shall follow MSS SP-45.

2.3 BRONZE BALL VALVES

- A. Ball Valves, 4 Inches and Smaller: MSS SP-110, Class 150, 600-psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for 1/2-inch valves and smaller and conventional port for 3/4-inch valves and larger; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections:

1. Operator: Steel handwheel.
2. Stem Extension: For valves installed in insulated piping.
3. Memory Stop: For operator handles.
4. operator.

2.4 BRONZE CHECK VALVES

- A. Swing Check Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections:
- B. Swing Check Valves, 3 Inches and Larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.

2.5 WAFER CHECK VALVES

- A. Class 125, 200-psi CWP, ASTM A 126 cast-iron body, bronze disc/plates, stainless-steel pins and springs, Buna N seals, installed between flanges.

2.6 BRONZE GATE VALVES

- A. Gate Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi cold working pressure (CWP), or Class 150, 300-psi CWP; ASTM B 62 cast-bronze body and bonnet, solid-bronze wedge, copper-silicon alloy rising stem, teflon-impregnated packing with bronze packing nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

2.7 BRONZE GLOBE VALVES

- A. Globe Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; ASTM B 62 cast-bronze body and screwed bonnet, rubber, bronze, or teflon disc, silicon bronze-alloy stem, teflon-impregnated packing with bronze nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or gate or plug valves.
 - 2. Throttling Service: Ball, butterfly, or globe valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Domestic Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
 - 2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
 - 3. Butterfly Valves, NPS 2-1/2 and Larger: Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.
 - 4. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
 - 5. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
 - 6. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
 - 7. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.
- D. Select valves, except wafer and flangeless types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water, steam, and steam condensate services.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.

- F. Install chainwheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.
- G. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

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

END OF SECTION 15110

SECTION 15140 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 2 Section "Excavation and Fill."
 - 2. Division 15 Section " Domestic Water Piping Specialties"
 - 3. Division 15 Section "Valves."
 - 4. Division 15 Section "Basic Mechanical Materials and Methods."
 - 5. Division 15 Section "Hangers and Supports."
 - 6. Division 15 Section "Plumbing Fixtures."

1.2 SUMMARY

- A. This Section includes domestic water piping inside the building.

1.3 DEFINITIONS – NOT APPLICABLE

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.

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 prevent entrance of dirt, debris, and moisture.

- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt..

1.7 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with 125 psig , unless otherwise indicated.

PART 2 - PRODUCTS

2.1 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.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A, Schedule 40, galvanized. Include ends matching joining method.
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body, with ball-and-socket, metal-to-metal, bronze seating surface and female threaded ends.
 - 3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
 - 4. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.
 - 6. Steel-Piping, Expansion Joints: Compound, galvanized steel fitting with telescoping body and slip-pipe section. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.

2.3 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Types K and L (ASTM B 88M, Types A and B), 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, Types K and L (ASTM B 88M,), 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.

- C. Ductile-Iron Pipe: AWWA C151, 250-psig minimum pressure rating with mechanical-joint bell, plain spigot end, and AWWA C104 cement-mortar lining.
 - 1. Include AWWA C111 ductile-iron gland, rubber gasket, and steel bolts with mechanical-joint pipe.
 - 2. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends conforming to AWWA C110 or AWWA C153. Include 2 gasketed ball-joint sections, 1 or more gasketed sleeve sections, 250-psig minimum working-pressure rating, and AWWA C550 epoxy interior coating. Assemble components for offset and expansion indicated. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.

2.4 VALVES

- A. Bronze and cast-iron, general-duty valves are specified in Division 15 Section "Valves."

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Excavation and Fill"

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. Under-Ground, Water-Service Piping on Service Side of Water Meter: Underground, Service Entrance Piping: Do not use flanges or valves underground. Use the following:
 - 1. NPS 2 (DN 50) and Smaller: Soft copper tube, Type K (Type A); copper pressure fittings; and soldered joints.
 - 2. 3- to 8-Inch NPS: Ductile-iron pipe and fittings, and mechanical joints.
- D. Domestic Water Piping on Service Side of Water Meter inside the Building: Use the following piping materials for each size range:
 - 1. NPS 4 and smaller (DN 100 to DN 150): Hard copper tube, Type K; copper pressure fittings; and soldered joints.

2. NPS 4 and larger (DN 100 to DN 150): Steel pipe; gray-iron, threaded fittings; and threaded joints.
- E. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
1. NPS 3 and smaller (DN 75 and smaller): Hard copper tube, Type L, copper pressure fittings; and soldered joints.
 2. NPS 4 to NPS 6 (DN 100 to DN 150): Steel pipe; gray-iron, threaded fittings; and threaded joints.
- F. Non-Potable-Water Piping: Use the following piping materials for each size range:
1. NPS 3 and smaller (DN 75 and smaller): Steel pipe; gray-iron, threaded fittings; and threaded 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 2-1/2 (DN 65) and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 3 (DN 75) and larger.
 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 (DN 50) and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 3. Hot-Water-Piping, Balancing Duty: Calibrated 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 2-1/2 (DN 65) and smaller. Use butterfly or gate valves for piping NPS 3 (DN 75) 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.
 2. Install stop-and-waste drain valves where indicated.
- D. Install calibrated balancing valves in each hot-water circulation return branch, in the hot water return main where branches join together and on discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Division 15 Section "Plumbing Specialties."

3.4 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 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 15 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.
- E. Install domestic water piping level without pitch and plumb.
- F. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

3.5 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 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.

3.6 WATER METER INSTALLATION

- A. Rough-in water piping for water meter installation according authority having jurisdiction requirements. Water meters shall be purchased from Department of Water Management.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 15 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 (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) 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 15 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 (10 mm).
- E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.

F. Install supports for vertical steel piping every 15 feet (4.5 m).

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

1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.

H. Install supports for vertical copper tubing every 10 feet (3 m).

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, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 15 Section "Plumbing Fixtures."

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 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND ADJUSTING

- A. Clean and disinfect potable and non-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 (50 mg/L) 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 (200 mg/L) 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.

- D. 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 CONTRACTOR STARTUP AND REPORTING

- A. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- B. Perform the following steps before putting into 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. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use
- C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- D. Check plumbing specialties and verify proper settings, adjustments, and operation.
- E. Energize pumps and verify proper operation.

END OF SECTION 15140

SECTION 15145 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 15 Section "Basic Mechanical Materials and Methods"
 - 2. Division 16 Section "Grounding and Bonding."
 - 3. Division 16 Section "Conductors and Cables."

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Temperature-actuated water mixing valves.
 - 4. Hose bibbs.
 - 5. Wall hydrants.
 - 6. Drain valves.
 - 7. Water hammer arresters.
 - 8. Air vents.

1.3 DEFINITIONS – NOT APPLICABLE

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

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. NSF Compliance:
 - 1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver specialties in factory-provided packaging. Maintain packaging through shipping, storage, and handling to prevent damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored specialties from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.7 PERFORMANCE REQUIREMENTS

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

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.
 - a. Pipe-Applied, Atmospheric-Type Vacuum Breakers
 - 1) Ames Co.
 - 2) Cash Acme.
 - 3) Conbraco Industries, Inc.
 - 4) Chicago Faucet
 - 5) FEBCO; SPX Valves & Controls.
 - 6) Watts Industries, Inc.; Water Products Div.
 - 7) Zurn Plumbing Products Group; Wilkins Div.
 - 8) or equal.
 - b. Laboratory-Faucet Vacuum Breakers
 - 1) Conbraco Industries, Inc.
 - 2) Watts Industries, Inc.; Water Products Div.
 - 3) Chicago Faucet
 - 4) Woodford Manufacturing Company.
 - 5) Zurn Plumbing Products Group; Wilkins Div.
 - 6) or equal.
 - c. Intermediate Atmospheric-Vent Backflow Preventers
 - 1) Cash Acme.

- 2) Conbraco Industries, Inc.
 - 3) FEBCO; SPX Valves & Controls.
 - 4) Honeywell Water Controls.
 - 5) Watts Industries, Inc.; Water Products Div.
 - 6) Zurn Plumbing Products Group; Wilkins Div.
 - 7) or equal.
- d. Reduced-Pressure-Principle Backflow Preventers
- 1) Ames Co.
 - 2) Conbraco Industries, Inc.
 - 3) FEBCO; SPX Valves & Controls.
 - 4) Watts Industries, Inc.; Water Products Div.
 - 5) Zurn Plumbing Products Group; Wilkins Div.
 - 6) or equal.
- e. Water-Temperature Limiting Devices
- 1) Leonard Valve Company.
 - 2) Powers; a Watts Industries Co.
 - 3) Symmons Industries, Inc.
 - 4) Lawler.
 - 5) Watts Industries, Inc.; Water Products Div.
 - 6) Zurn Plumbing Products Group; Wilkins Div.
 - 7) or equal.
- f. Individual-Fixture, Water Tempering Valves
- 1) Conbraco Industries, Inc..
 - 2) Lawler Manufacturing Company, Inc.
 - 3) Leonard Valve Company.
 - 4) Powers; a Watts Industries Co.
 - 5) Watts Industries, Inc.; Water Products Div.
 - 6) Symmons Industries, Inc.
 - 7) Zurn Plumbing Products Group; Wilkins Div.
 - 8) or equal.
- g. Nonfreeze Wall Hydrants
- 1) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 4) Tyler Pipe; Wade Div.
 - 5) Woodford Manufacturing Company.
 - 6) Zurn Plumbing Products Group; Specification Drainage Operation.
 - 7) or equal.
- h. Water Hammer Arresters
- 1) Josam Company
 - 2) MIFAB, Inc.
 - 3) PPP Inc.
 - 4) Sioux Chief Manufacturing Company, Inc.
 - 5) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

- 6) Tyler Pipe; Wade Div.
- 7) Watts Drainage Products Inc.
- 8) Zurn Plumbing Products Group; Specification Drainage Operation.
- 9) or equal.

2.2 VACUUM BREAKERS

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

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze in unfinished back of house areas, chrome plated where exposed to public.

2.3 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers :

1. Standard: ASSE 1012.
2. Operation: Continuous-pressure applications.
3. Size: Same as pipe size.
4. Body: Bronze.
5. End Connections: Union, solder joint.
6. Finish: Rough bronze in unfinished back of house areas, chrome plated where exposed to public.

B. Reduced-Pressure-Principle Backflow Preventers :

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.
4. Size: Same as pipe size.
5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
7. Configuration: Designed for horizontal, straight through or vertical inlet, horizontal center section, and vertical outlet flow as applicable.
8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves (2 inch and smaller):

1. Type: Y-pattern globe valve with two readout ports and memory setting indicator.
2. Body: Bronze.
3. Size: Same as connected piping, but not larger than NPS 2 (DN 50).
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves (2-12 inch and larger):

1. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
2. Size: Same as connected piping, but not smaller than NPS 2-1/2 (DN 65).
3. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

C. Individual-Fixture, Water Tempering Valves:

1. Standard: ASSE 1016, thermostatically controlled water tempering valve.
2. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
3. Body: Bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Inlets and Outlet: Threaded.
6. Finish: Rough or chrome-plated bronze.
7. Tempered-Water Setting: 105 deg F.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers :

1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 (DN 50) and Smaller: 0.033 inch (0.84 mm) .
 - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.062 inch (1.57 mm).
 - c. Strainers NPS 5 (DN 125) and Larger: 0.125 inch (3.18 mm).
6. Drain: Factory-installed, hose-end drain valve.

2.6 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 3/4 (DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (860 kPa).
7. Vacuum Breaker: Field-installed, elevated, drainable, vacuum breaker complying with ASSE 1011, mounted 7 feet 6 inches minimum above finished floor.

8. Finish for Equipment Rooms: Rough bronze.
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.

2.7 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig (860 kPa).
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 (DN 20).
6. Provide with testable double check valve on inlet per authority having jurisdiction requirements.
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): Two with each wall hydrant.

2.8 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 (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
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.

B. Stop-and-Waste Drain Valves :

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig (1380-kPa) minimum CWP or Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 (DN 6) side outlet with cap.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters :

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

2.10 AIR VENTS

A. Bolted-Construction Automatic Air Vents :

1. Body: Bronze.
2. Pressure Rating: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C).
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 (DN 15) minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15 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 water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- E. Install balancing valves in locations where they can easily be adjusted.
- F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install thermometers and water regulators if specified.

- G. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- H. Install water hammer arresters in water piping according to PDI-WH 201.
- I. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 16 Section "Grounding and Bonding."
- C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

COORDINATE LIST BELOW WITH PRODUCTS RETAINED IN PART 2.

- 1. Pressure vacuum breakers.
 - 2. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principle backflow preventers.
 - 4. Water pressure-reducing valves.
 - 5. Calibrated balancing valves.
 - 6. Primary water tempering valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15 Section "Mechanical Identification."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 CLEANING AND ADJUSTING

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

- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

3.6 CONTRACTOR STARTUP AND REPORTING

- A. Before startup, perform the following checks:
 - 1. System tests are complete.
 - 2. Damaged and defective specialties and accessories have been replaced or repaired.
 - 3. Clear space is provided for servicing specialties.
- B. Before operating systems, perform the following steps:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open general-duty valves to fully open position.
 - 3. Remove and clean strainers.
 - 4. Verify that drainage and vent piping are clear of obstructions. Flush with water until clear.
- C. Startup Procedures: Follow manufacturer's written instructions. If no procedures are prescribed by manufacturer, proceed as follows:
 - 1. Energize circuits for electrically operated units. Start and run units through complete sequence of operations.
- D. Adjust operation and correct deficiencies discovered during startup.

END OF SECTION 15145

INTENTIONALLY LEFT BLANK

SECTION 15150 - 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, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 2 "Excavation and Fill".
 - 2. Division 15 "Basic Materials and Methods".
 - 3. Division 15 "Hangers and Supports".

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. None Required.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE AND HANDLING – NOT APPLICABLE

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified, or equal.

1. Flexible, Nonpressure Pipe Couplings:

- a. Fernco, Inc.
- b. Logan Clay Products Company (The).
- c. Mission Rubber Co.
- d. NDS, Inc.
- e. or equal.

2. Shielded Nonpressure Pipe Couplings:

- a. Cascade Waterworks Mfg. Co.
- b. Mission Rubber Co.
- c. or equal.

3. Rigid, Unshielded, Nonpressure Pipe Couplings:

- a. ANACO
- b. or equal.

4. Pressure Pipe Couplings:

- a. Cascade Waterworks Mfg. Co.
- b. Dresser, Inc.; DMD Div.
- c. EBAA Iron Sales, Inc.
- d. JCM Industries, Inc.
- e. Romac Industries, Inc.
- f. or equal.

5. Expansion Joints:

- a. EBAA Iron Sales, Inc.
- b. Romac Industries, Inc.
- c. Star Pipe Products; Star Fittings Div.
- d. or equal.

6. Wall-Penetration Fittings:

- a. SIGMA Corp.
- b. or equal.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

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

- A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 PVC SCHEDULE 40

- A. ASTM D 2665; ASTM D 2449; ASTM F 891; CSA CAN/CSA-B181.2 and Fittings: ASTM A 74.
- B. Use shall be limited to gravity drainage and venting only and shall not be used for pressurized drain , waste or venting applications.

2.5 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
- B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.
- C. Pressure Fittings:
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
 - 4. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.

2.6 DUCTILE-IRON PIPE AND FITTINGS

- A. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
 - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Gaskets: AWWA C111, rubber.
- B. Flanges: ASME 16.1, Class 125, cast iron.

2.7 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.
 - 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
 - 2. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 3. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 4. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), 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.

2.8 SPECIAL PIPE FITTINGS

- A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Sleeve Materials:
 - a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Center-Sleeve Material: Stainless steel.
 - 2. Gasket Material: Natural or synthetic rubber.
 - 3. Metal Component Finish: Corrosion-resistant coating or material.
- D. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
- E. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

2.9 ENCASUREMENT FOR UNDERGROUND METAL PIPING

- A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Excavation and Fill" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 3 (DN 75) and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; lead and oakum joints.
 - 2. Steel pipe, drainage fittings, and threaded joints.
 - 3. PVC schedule 40
 - 4. Dissimilar Pipe-Material Couplings: Rigid, unshielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Aboveground, soil and waste piping NPS 4 (DN 100) and larger shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; lead and oakum joints.
- D. Aboveground, vent piping NPS 3 (DN 75) and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; lead and oakum joints.
 - 2. Steel pipe, drainage fittings, and threaded joints.
 - 3. Stainless-steel pipe and fittings gaskets, and gasketed joints.
 - 4. PVC schedule 40.
 - 5. Dissimilar Pipe-Material Couplings: Rigid, unshielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- E. Aboveground, vent piping NPS 4 (DN 100) and larger shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; lead and oakum joints.
- F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and larger shall be the following:
 - 1. Service Class Extra-Heavy (where required to connect to existing), cast-iron soil piping; gaskets; and gasketed joints.
- G. Aboveground sanitary-sewage force mains NPS 1-1/2 to NPS 3 (DN 40 and DN 75) shall be any of the following:

1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
 2. Steel pipe, pressure fittings, and threaded joints.
- H. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller shall be any of the following:
1. Soft copper tube, Type L (Type B); wrought-copper pressure fittings; and soldered joints.
 2. Steel pipe, pressure fittings, and threaded joints.
 3. Push-on-joint, ductile-iron pipe; push-on-joint ductile-iron fittings; gaskets; and gasketed joints.
 4. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 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 cleanout fitting with closure plug inside the building in sanitary force-main piping.
- D. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- E. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- F. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- G. 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 15 Section "Basic Mechanical Materials and Methods."
- H. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- I. 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.

- J. 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.
- K. 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 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- L. Install engineered soil and waste drainage and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
- M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- N. 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 15 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. 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 15 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 (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
- 3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) 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 15 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 (10-mm) 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 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
 - 4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
 - 5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
 - 4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
 - 5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
 - 6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
 - 7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
 - 8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
- H. Install supports for vertical steel piping every 15 feet (4.5 m).
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
 - 4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
 - 5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
 - 6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- J. Install supports for vertical copper tubing every 10 feet (3 m).

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, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.
- D. Connect force-main piping to the following:
 - 1. Sanitary Sewer: To exterior force main or sanitary manhole.

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 (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.8 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 (30 kPa).
 2. Sanitary Sewer, Force-Main Piping: 100 psig (690 kPa).

3.9 CLEANING AND ADJUSTING

- 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 15150

SECTION 15155 - DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast in Place Concrete."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. This Section includes the following drainage piping specialties:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Floor drains.
 - 4. Roof flashing assemblies.
 - 5. Through-penetration firestop assemblies.
 - 6. Roof drains.
 - 7. Miscellaneous drainage piping specialties.
 - 8. Flashing materials.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PUR: Polyurethane plastic.
- H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Shop Drawings: Provide shop drawings of plumbing equipment as required in Pace's Contract Requirements..
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 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.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary and storm piping specialty components.

1.6 DELIVERY, STORAGE AND HANDLING.

- A. Deliver specialties in factory-provided packaging. Maintain packaging through shipping, storage, and handling to prevent damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored specialties from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate size and location of roof penetrations.

1.8 EXTRA MATERIALS –NOT APPLICABLE

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified or equal.
 - 1. Exposed Metal Cleanouts

- a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation
 - f. or equal.
2. Cast Iron Cleanouts
- a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation
 - f. or equal.
3. Cast-Iron Wall Cleanouts
- a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation
 - f. or equal.
4. Cast-Iron Floor Drains
- a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation
 - f. or equal.
5. Through-Penetration Firestop Assemblies
- a. ProSet Systems Inc.
 - b. B-Line
 - c. or equal.

2.2 STANDARD CLEANOUTS

A. Exposed Metal Cleanouts CO:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.
- 2. Standard: ASME A112.36.2M for cast iron cleanout test tee.
- 3. Size: Same as connected drainage piping up to 4 inch diameter, 4 inch for larger piping.
- 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
- 5. Closure: Countersunk or raised-head, brass plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts FCO:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.
2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch up to 4 inch diameter, 4 inch for larger piping.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Spigot.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Polished bronze.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Extra Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts WCO:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping up to 4 inch diameter, 4 inch for larger piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: (frame and cover to be installed in drywall) Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
8. (stainless-steel wall-installation frame and cover to be used in other areas) Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.3 STANDARD FLOOR DRAINS AND CLEANOUTS

A. Floor Drain FD-1: Where plumbing specialties of this designation are indicated, provide products complying with the following:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.
2. Applicable Standard: ASME A112.21.1M
3. Body Material: Cast iron.
4. Seepage Flange: Required.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Sediment Bucket: Not required.
8. Top or Strainer Material: Cast iron.
9. Top of Body and Strainer Finish: Polished brass.
10. Top Shape: Round.
11. Dimensions of Top or Strainer: 6"
12. Top Loading Classification: Light Duty.
13. Funnel: Not required.
14. Funnel Dimensions: Not required.

15. Inlet Fitting: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.
16. Trap Material: Cast iron.
17. Trap Pattern: Standard P-trap.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

2.5 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches (51 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

B. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated: (Coordinate with Division 7).

1. General Applications: 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).
2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm thickness).

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) 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 (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
 - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
 - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

- F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- G. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
- H. Install deep-seal traps on floor drains and other waste outlets, unless otherwise indicated.
- I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- L. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- M. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- O. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.5 CONTRACTOR STARTUP AND REPORTING

- A. Perform the following final checks before startup:
 1. Verify that specified tests of piping systems are complete.

END OF SECTION 15155

SECTION 15160 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 2 Section "Excavation and Fill."
 - 2. Division 15 Section "Basic Mechanical Materials and Methods."
 - 3. Division 15 Section "Valves."
 - 4. Division 15 Section "Hangers and Supports."

1.2 SUMMARY

- A. This Section includes the following storm drainage piping inside the building:
 - 1. Pipe, tube, and fittings for drainage and drain tile.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.
- B. TPE: Thermoplastic elastomer.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- 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 and "NSF-sewer" for plastic sewer piping.

1.6 DELIVERY, STORAGE AND HANDLING – NOT APPLICABLE

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Flexible, Nonpressure Pipe Couplings:
 - a. Fernco, Inc.
 - b. Logan Clay Products Company (The).
 - c. Mission Rubber Co.
 - d. NDS, Inc.
 - e. or equal.
2. Shielded Nonpressure Pipe Couplings:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
 - c. or equal.
3. Rigid, Unshielded, Nonpressure Pipe Couplings:
 - a. ANACO
 - b. or equal.
4. Pressure Pipe Couplings:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser, Inc.; DMD Div.
 - c. EBAA Iron Sales, Inc.
 - d. JCM Industries, Inc.
 - e. Romac Industries, Inc.
 - f. or equal.
5. Expansion Joints:
 - a. EBAA Iron Sales, Inc.
 - b. Romac Industries, Inc.
 - c. Star Pipe Products; Star Fittings Div.
 - d. or equal.
6. Wall-Penetration Fittings:
 - a. SIGMA Corp.
 - b. or equal.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

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

- A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
- B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.
- C. Pressure Fittings:
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
 - 4. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.

2.5 DUCTILE-IRON PIPE AND FITTINGS

- A. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
 - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Gaskets: AWWA C111, rubber.
- B. Flanges: ASME 16.1, Class 125, cast iron.

2.6 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.
 - 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
 - 2. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 3. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

4. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), 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.

2.7 SPECIAL PIPE FITTINGS

- A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
1. Sleeve Materials:
 - a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
1. Center-Sleeve Material: Stainless steel.
 2. Gasket Material: Natural or synthetic rubber.
 3. Metal Component Finish: Corrosion-resistant coating or material.
- E. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
- F. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Excavation and fill" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; and lead and oakum joints.
 - 2. Steel pipe, drainage fittings, and threaded joints.
 - 3. Copper tube, copper drainage fittings, and soldered joints.
 - 4. Dissimilar Pipe-Material Couplings: Rigid, unshielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Aboveground, storm drainage piping NPS 8 (DN 200) and larger shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; and lead and oakum joints.
- D. Underground storm drainage piping NPS 6 (DN 150) and smaller shall be the following:
 - 1. Extra-heavy (where require to match existing) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
- E. Underground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
 - 1. Extra-Heavy (where require to match existing) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- F. Aboveground storm drainage force mains NPS 1-1/2 to NPS 3 (DN 40 and DN 75) shall be any of the following:
 - 1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
 - 2. Steel pipe, pressure fittings, and threaded joints.
- G. Aboveground storm drainage force mains NPS 4 and Larger shall be the following:
 - 1. Steel pipe, pressure fittings, and threaded joints.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 15 Section "Plumbing Specialties."
- C. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- D. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105.
- E. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping

outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- F. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- G. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- H. 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 15 Section "Basic Mechanical Materials and Methods."
- I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping according to ASTM A 674 or AWWA C105 where indicated on drawings.
- J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- M. Install force mains at elevations indicated.
- N. Install engineered controlled-flow storm drainage piping in locations indicated.
- O. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- P. Install underground PVC storm drainage piping according to ASTM D 2321.
- Q. 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 15 Section "Basic Mechanical Materials and Methods."
- 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. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- D. 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.
- E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 15 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, 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 15 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 (DN 40 and DN 50): 60 inches with 3/8-inch rod.
 - 2. NPS 3 (DN 80): 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches with 5/8-inch rod.
 - 4. NPS 6 (DN 150): 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches with 7/8-inch rod.
 - 6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 84 inches with 3/8-inch rod.
 2. NPS 1-1/2 (DN 40): 108 inches with 3/8-inch rod.
 3. NPS 2 (DN 50): 10 feet with 3/8-inch rod.
 4. NPS 2-1/2 (DN 65): 11 feet with 1/2-inch rod.
 5. NPS 3 (DN 80): 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet with 5/8-inch rod.
 7. NPS 6 (DN 150): 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches with 3/8-inch rod.
 3. NPS 2-1/2 (DN 65): 108 inches with 1/2-inch rod.
 4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet with 1/2-inch rod.
 5. NPS 6 (DN 150): 10 feet with 5/8-inch rod.
 6. NPS 8 (DN 200): 10 feet with 3/4-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.
- K. 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 interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
- D. Connect force-main piping to the following:
1. Storm Sewer: To exterior force main or storm manhole.
 2. Sump Pumps: To sump pump discharge.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping, 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. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

3.8 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.
 - 2. Storm Drainage, Force-Main Piping: 100 psig.

3.9 CLEANING AND ADJUSTING

- 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 15160

INTENTIONALLY LEFT BLANK

SECTION 15410 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:

1. Faucets for lavatories and sinks.
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. Fixture supports.
6. Water closets.
7. Urinals.
8. Lavatories.
9. Service sinks.
10. Service basins.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Drinking Fountain: Fixture that can be approached and used by people with disabilities.
- C. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- D. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- E. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- F. 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.
- G. FRP: Fiberglass-reinforced plastic.
- H. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- I. PMMA: Polymethyl methacrylate (acrylic) plastic.

- J. PVC: Polyvinyl chloride plastic.
- K. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.
- L. Tepid: Moderately warm.

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: Provide per contract requirements.
- C. Operation and Maintenance Data: For plumbing fixtures to include, operation, and maintenance manuals.

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. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 3. Vitreous-China Fixtures: ASME A112.19.2M.
 - 4. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 - 5. Water-Closet, Flushometer Tank Trim: ASSE 1037.

- H. Comply with the following applicable standards and other requirements specified:
1. Faucets: ASME A112.18.1.
 2. Hose-Connection Vacuum Breakers: ASSE 1011.
 3. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 4. NSF Potable-Water Materials: NSF 61.
 5. Pipe Threads: ASME B1.20.1.
 6. Sensor-Actuated Faucets, Flushometers and Electrical Devices: ASSE 1037 and UL 1951.
 7. Supply Fittings: ASME A112.18.1.
 8. Brass Waste Fittings: ASME A112.18.2.
 9. Floor Drains: ASME A112.6.3.
 10. Grab Bars: ASTM F 446.
 11. Hose-Coupling Threads: ASME B1.20.7.
 12. Off-Floor Fixture Supports: ASME A112.6.1M.
 13. Pipe Threads: ASME B1.20.1.
 14. Plastic Toilet Seats: ANSI Z124.5.
 15. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE AND HANDLING – NOT APPLICABLE

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Washers and O-Rings: Equal to (2) of each type and size installed.
 2. Faucet Cartridges and O-Rings: Equal to (2) of amount of each type and size installed.
 3. Flushometer Valve, Repair Kits: Equal to (1) of each type installed.
 4. Flushometer Tank, Repair Kits: Equal to (1) of each type installed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Lavatory Faucets
1. American Standard Companies, Inc.
 2. Chicago Faucets.
 3. Kohler Co.
 4. Moen, Inc.- Commercial
 5. Sloan Valve Co., Optima.
 6. Zurn Plumbing Products Group; Commercial Brass Operation
 7. or equal.
- B. Sink/ Mop Basin Faucets:
1. American Standard Companies, Inc.
 2. Chicago Faucets.
 3. Elkay Manufacturing Co.
 4. Kohler Co.

5. Moen, Inc.- Commercial
6. T & S Brass and Bronze Works, Inc.
7. Zurn Plumbing Products Group; Commercial Brass Operation
8. or equal.

C. Flushometers:

1. Coyne & Delany Co.
2. Moen, Inc.,-Commercial
3. Sloan Valve Company.
4. Zurn Plumbing Products Group; Commercial Brass Operation
5. or equal.

D. Toilet Seats:

1. Centoco Manufacturing Corp.
2. Church Seats.
3. Olsonite Corp
4. or equal.

E. Protective Shielding Pipe Covers,:

1. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
2. McGuire Manufacturing Co., Inc.
3. Plumberex Specialty Products Inc.
4. TCI Products.
5. TRUEBRO, Inc
6. or equal.

F. Fixture Supports

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Zurn Plumbing Products Group; Specification Drainage Operation
6. or equal.

G. Water Closets:

1. American Standard Companies, Inc.
2. Crane Plumbing, L.L.C./Fiat Products.
3. Eljer.
4. Kohler Co
5. or equal.

H. Urinals:

1. American Standard Companies, Inc.
2. Crane Plumbing, L.L.C./Fiat Products.
3. Eljer.
4. Kohler Co
5. or equal.

I. Lavatories:

1. Acorn Engineering Company.
2. American Standard Companies, Inc.
3. Commercial Enameling Company.
4. Crane Plumbing, L.L.C./Fiat Products.
5. Eljer.
6. Elkay Manufacturing Co.
7. Intersan Manufacturing Company.
8. Just Manufacturing Company.
9. Kohler Co
10. or equal.

J. Service Basins:

1. Crane Plumbing, L.L.C./Fiat Products.
2. Florestone Products Co., Inc.
3. Precast Terrazzo Enterprises, Inc.
4. Stern-Williams Co., Inc.
5. or equal.

K. Water-Tempering Equipment:

1. Bradley Corporation.
2. Haws Corporation.
3. Lawler Manufacturing Co., Inc.
4. Leonard Valve Company.
5. Powers, a Watts Industries Co.
6. or equal.

2.2 STANDARD FIXTURE SCHEDULE

A. Accessible Water Closet WC: Where plumbing fixtures of this designation are indicated, provide products complying with the following (Refer also to drawings):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.
2. Fixture Color: White.
3. Bowl Type and Operation: Elongated, siphon jet.
4. Mounting and Outlet: Wall hanging, back outlet.
5. Fixture Bolt Caps: White, plastic or china.
6. Rim Height: 17-1/2 inches to 18 inches.
7. Design Water Consumption: 1 gal. per flushing cycle.
8. Flushometer Valve Construction: Cast-brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, and vacuum breaker.
9. Flushometer Valve Operation: Electronic Infrared, per schedule on drawings.
10. Flushometer Valve Finish: Polished, chrome-plated, exposed metal parts.
11. Flushometer Valve, Water Consumption: Factory set or field adjusted, 1 gal. maximum per flushing cycle.
12. Flushometer valve components include the following:
 - a. Brass, self adaptive infrared sensor with indicator light, as indicated on drawings.
 - b. Hardwire Transformer: 120 VAC/24VAC 50 VA Hard Wire.
 - c. Dual filtered by-pass.
 - d. Integral solenoid operator.

- e. Manual over-ride button.
 - f. Chrome plated wall cover plate with vandal-resistant screws.
 - g. Seat bumper on stop.
 - h. Tailpiece trap-primer connection where required.
13. Supply Inlet: 1 inch NPS with wall flange.
 14. Supply Stop: Loose key.
 15. Supply Riser: 1 inch NPS, rigid riser with collar end.
 16. Toilet Seat: Solid-plastic, water-closet seat with bumpers and stainless steel hardware, compatible with water closet and as follows:
 - a. Color: White.
 - b. Class: Commercial, Extra-Heavy-Duty type, exceeding requirements of Commercial, Standard class.
 - c. Size: Elongated.
 - d. Pattern: Open front without cover.
 - e. Hinge Type: Check (CK).
 17. Fixture Support: Vertically adjustable, cast-iron, elevated-type, water-closet carrier with combination support and waste fitting assemblies and tiling frame or setting gage. Include additional faceplate and coupling for water closet at wide pipe space. Compact-type carrier for back-to-back water-closet installation is prohibited.
- B. Accessible Urinal UR: Where plumbing fixtures of this designation are indicated, provide products complying with the following:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1 (Refer also to drawings).
 2. Fixture Color: White.
 3. Type and Operation: Siphon jet.
 4. Mounting and Outlet: Wall hanging, back outlet.
 5. Fixture Bolt Caps: White, plastic or china.
 6. Rim Height: 17 inches.
 7. Design Water Consumption: 0.125 gal. per flushing cycle.
 8. Flushometer Valve Construction: Cast-brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, and vacuum breaker.
 9. Flushometer Valve Operation: Electronic Infrared, per schedule on drawings.
 10. Flushometer Valve Finish: Polished, chrome-plated, exposed metal parts.
 11. Flushometer Valve, Water Consumption: Factory set or field adjusted, 0.125 gal. maximum per flushing cycle.
 12. Flushometer valve components include the following:
 - a. Brass, self adaptive infrared sensor with indicator light, as indicated on drawings.
 - b. Hardwire Transformer: 120VAC/24 VAC 50 VA Hard Wire (if indicated on drawings).
 - c. Dual filtered by-pass.
 - d. Integral solenoid operator.
 - e. Manual over-ride button.
 - f. Chrome plated wall cover plate with vandal-resistant screws.
 - g. Tailpiece, trap-primer connection where required.
- C. Type I Fixture Support, vertically adjustable, urinal, chair carrier with coupling; heavy-duty, rectangular-steel, upright members; bearing plate; and feet.

- D. Accessible Lavatory LAV: Where plumbing fixtures of this designation are indicated, provide products complying with the following:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1 (Refer also to drawings).
 2. Fixture Color: White.
 3. Fixture Dimensions: 20-1/2 inches x 18-1/4 inches
 4. Fixture Faucet-Hole Spacing: Single hole, centered
 5. Mounting: Wall hanging.
 6. Faucet Construction: Cast-brass underbody and brass escutcheon, and without pop-up waste.
 7. Faucet Valve Operation: Electronic sensor operated, per schedule on drawings.
 8. Faucet Mounting Position: Centered on fixture deck.
 9. Faucet Components: Include the following:
 - a. Accessible-Fixture Operation: Electronic infrared solenoid operated, splash proof circuit module.
 - b. Handles: Sensor range adjustable screw.
 - c. Trouble shooting LED indicator lights.
 - d. Variable time out settings.
 - e. Filtered solenoid valve with serviceable 'y' strainer.
 - f. Module quick-release sensor and solenoid connections.
 - g. Spout: Fixed-position gooseneck.
 - h. Spout Length, Centerline of Inlets to Outlet: 5-3/8 inch
 - i. Spout Outlet: Manufacturer's standard aerator.
 - j. Spout-Outlet, Flow-Control Fitting: 1/2 gpm.
 - k. Transformer: 120 VAC/24VAC 50/60 Hz Box Mount.
 10. Mixing Valve: Use the following:
 - a. ASSE 1016 thermostatic mixing valve suitable for single faucet operation with back checks and angle stops, brass construction, solid bimetal thermostat, adjustable high limit stop, stainless steel internal parts and adjustment knob.
 11. Supply Inlets: 3/8-inch NPS, brass pipe or copper tubing.
 12. Supply Stops: Manufacturer's standard brass, angle or straight, compression, loose-key type, same size as supply inlet and with outlet matching supply riser.
 13. Supply Risers: 3/8-inch NPS rigid with 1/4-inch NPS offset, knob-end tailpiece.
 14. Supply, Flow-Control Restrictors: 3/8-inch NPS, 1/2 gpm.
 15. Drain: Grid strainer with 1-1/4-inch NPS offset waste.
 16. Tubular Trap: 1-1/2-by-1-1/4-inch NPS, 0.045-inch wall thickness, tubular brass, with slip-joint inlet and wall flange.
 17. Supply Insulation Kit: Molded, soft-plastic covering for supplies from wall to fixture with removable covering for stops and handles. Include manufacturer's standard fasteners, straps, and adhesives.
 18. Drain Insulation Kit: Molded, soft-plastic covering for drain piping from fixture to wall. Include manufacturer's standard fasteners, straps, and adhesives.
 19. Fixture Support: Type II, concealed arm; vertically adjustable, lavatory, chair carrier with heavy-duty, rectangular-steel, upright members; and feet.
- E. Mop-Service Basin MB: Where plumbing fixtures of this designation are indicated, provide products complying with the following:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.

2. Fixture Dimensions: 24 inches x 24 inches x 12 inches deep.
3. Mounting: Floor.
4. Rim Guard: Manufacturer's standard.
5. Faucet: Widespread, cast brass with supplies on 8-inch centers.
6. Faucet Mounting: Wall, centered on fixture.
7. Faucet Components: Include the following:
 - a. Finish: Polished chrome.
 - b. Handles: Dual lever or 4 arm.
 - c. Supply Stops: Integral, in shanks.
 - d. Spout: With elevated vacuum breaker, pail hook, and hose-thread outlet.
 - e. Wall Brace: Assembly with wall bracket and support to faucet spout.
 - f. Hose: 30-inch-minimum, flexible hose with stainless-steel hose wall bracket.
8. Drain: 3-inch NPS with grid strainer.
9. P-Trap: 3-inch NPS drainage piping.
10. Supplies: 1/2-inch NPS copper tubing with ball, gate, or globe valve.

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 wall-mounting fixtures with tubular waste piping attached to supports.
- E. Install counter-mounting fixtures in and attached to casework.
- F. Install fixtures level and plumb according to roughing-in drawings.

- G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 15 Section "Valves."
- H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- J. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- K. Install toilet seats on water closets.
- L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- M. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- 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 traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- P. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 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 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.

3.6 CLEANING AND ADJUSTING

- 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.
- C. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- D. Operate and adjust disposers and controls. Replace damaged and malfunctioning units and controls.
- E. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- F. Replace washers and seals of leaking and dripping faucets and stops.
- G. Install fresh batteries in sensor-operated mechanisms.

END OF SECTION 15410

SECTION 15766 – ELECTRIC WALL AND CEILING HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. All sections of Division 15 and 16 apply to this section.

1.2 SUMMARY

- A. This Section includes cabinet unit heaters with centrifugal fans and hot-water, steam and electric-resistance heating coils.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- 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. Plans, elevations, sections, and details.
 - 2. Location and size of each field connection.
 - 3. Location and arrangement of integral controls.
 - 4. Wiring Diagrams: Power, signal, and control wiring.
 - 5. Perimeter moldings for exposed or partially exposed cabinets.
- C. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
- D. Samples for Verification: Finish colors for each type of heater indicated with factory-applied color finishes.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For wall heaters to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE AND HANDLING

- A. Follow manufacturer's instructions for job site storage and protection of materials during construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Electric Units:
 - a. Markel
 - b. Chromalox, Inc.; a division of Emerson Electric Company.
 - c. Indeeco.
 - d. Marley Electric Heating; a division of Marley Engineered Products.
 - e. Rittling
 - f. or equal.

2.2 ELECTRIC HEATERS

- A. Description: A factory-assembled and -tested complying with ARI 440.
 1. Comply with UL 2021.
- B. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be aluminum-foil facing to prevent erosion of glass fibers.
 1. Thickness: 1 inch .
 2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
 5. Base: Minimum 0.0528-inch thick steel, finished to match cabinet, 6 inches high with leveling bolts.
- C. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide. Insulating refractory; and sealed in a high-mass steel or corrosion-resistant metallic sheath with fins a minimum of 0.16 inch apart. Provide fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware. Fin surface temperature shall not exceed 550 deg. F at any point during normal operation.

- D. Fan and Motor Board: Removable.
 - 1. Fan: Propeller; directly connected to motor. Provide thermoplastic or painted-steel wheels and galvanized-steel fan scrolls.
 - 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 15 Section "Motors."
 - 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

- E. Control devices and operational sequences are specified in Division 15 Section "Sequence of Operation."

- F. Basic Unit Controls:
 - 1. Control voltage transformer.
 - 2. Timer switch.
 - 3. Safety-switch disconnect on cover of terminal box.
 - 4. Mercury contactors.
 - 5. Fan-delay relay.
 - 6. Aquastat with adjustable setpoint interlocked with fan.
 - 7. Unit-mounted thermostat with the following features.
 - a. Heat-off switch.
 - b. Fan on-auto switch.
 - c. Manual fan speed switch.
 - d. Adjustable deadband.
 - e. Exposed set point.
 - f. Exposed indication.
 - g. Deg F indication.

- G. Electrical Connection: Factory wire motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive wall heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for electrical connections to verify actual locations before heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall boxes in finished wall assembly; seal and weatherproof.
- B. Install heaters to comply with NFPA 90A.

3.3 CLEANING

- A. After construction and painting are completed, clean all exposed surfaces and vacuum interiors.

- B. Retouch marred or scratched surfaces of cabinets. If units have factory-finished cabinets, use materials furnished by the manufacturer.

3.4 CONTRACTOR STARTUP AND REPORTING

- A. 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 motor rotation and unit operation.
 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 15766

SECTION 15769 – ELECTRIC INFRARED HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. All sections of Division 15 and 16 apply to this section.

1.2 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, specialties, and accessories for each product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and suspension and attachment. 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.
- C. Coordination Drawings: Reflected ceiling plan(s) 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. Structural members to which heaters and suspension systems will be attached.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of terminal units, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years. All products are to have catalogue performance data and certified test data.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.
- B. Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

1.6 COORDINATION

- A. Coordinate layout and installation of heaters with structure that is supported by them, including

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Markel
 - 2. or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive infrared heating units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install infrared heating units level and plumb.
- B. Support radiant heaters from structure as shown on drawings. Provide support mechanism.
- C. Verify locations of push button to activate heaters with Drawings and room details before installation. Install devices 48 inch above finished floor.

3.3 CLEANING

- A. After construction and painting are completed, clean all exposed surfaces and vacuum interiors.
- B. Retouch marred or scratched surfaces. If units have factory-finished cabinets, use materials furnished by the manufacturer.

3.4 CONTRACTOR STARTUP AND REPORTING

- A. Testing: Perform the following field tests and inspections and prepare test reports:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and units.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. After installing panels, inspect heaters for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

END OF SECTION 15769

INTENTIONALLY LEFT BLANK

SECTION 15815 METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes metal ducts for exhaust air-distribution systems for pressure class minus two (2)- inch wg. Metal ducts include the following:

1. Rectangular ducts and fittings.

1.2 DEFINITIONS

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
2. Joints: Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Hanger and Support Design: Hangers and supports shall comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."

1.4 SUBMITTALS

- A. Shop Drawings: Drawn at a scale of not less than 1/4" = 1'-0". Show fabrication and installation details for metal ducts.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment and vibration isolation.

- B. Delegated-Design Submittal:

1. Spacing of hangers and supports.

2. Design calculations: Calculations, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.
- C. Coordination Drawings: Reflected ceiling plans, 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. Ceiling suspension assembly members.
 2. Other systems installed in same space as ducts.
 3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
 4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- D. Field quality-control test reports.
- 1.5 QUALITY ASSURANCE
- A. Welding: Qualify procedures and personnel according to AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance:
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.
- 1.6 DELIVERY, STORAGE AND HANDLING
- A. All materials shall be stored in a designated area and protected from inclement weather.
- B. All materials shall be secured so as not to be a hazard during the construction process.
- C. Store ductwork with tight-fitting seals on open ends to ensure ductwork is free of all dirt, debris and moisture during the installation process.

PART 2 - PRODUCTS

2.1 SHEET METAL 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: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- E. Insulated Flexible Ducts: Flexible ducts wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.

2.2 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes combinations of open-weave fabric strips and mastics.
- B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- C. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- D. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.3 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hangers Installed in Corrosive Atmospheres: All-thread rods used in pool areas, pool equipment rooms, and pool supporting spaces shall be aluminum if the ducts are aluminum and stainless steel if the ducts are stainless steel.
 - 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
 - 3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Supports for Aluminum Ducts: Aluminum support materials..

2.4 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
1. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
 2. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
1. Exhaust Ducts (Negative Pressure): -2".
- B. All ducts shall be galvanized steel except as follows:

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install ducts with fewest possible joints.
- C. Install fabricated fittings for changes in directions, size, and shape and for connections.
- D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

- I. Coordinate layout with suspended ceiling, fire- and control dampers, lighting layouts, and similar finished work.
- J. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- K. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- M. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7.
- N. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.3 SEAM AND JOINT SEALING

- A. Seal all duct seams and joints to the most severe requirement between the latest Chicago Building Code and SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
- B. Utilize sealant designed for outdoor use with ductwork exposed to the outdoors.
- C. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. For concrete structure installations: Install concrete inserts before placing concrete.
- E. For concrete structure installations: Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 15 Section "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 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 - 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 - 3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
 - 4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION 15815

SECTION 15820 DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Flexible connectors.

1.3 DEFINITIONS – NOT APPLICABLE

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backdraft dampers.
 - 2. Flexible connectors.
- 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. Special fittings.
 - 2. Backdraft dampers.
 - 3. Flexible connectors.
 - 4. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.6 DELIVERY, STORAGE AND HANDLING

- A. Materials delivered to the site must be coordinated with the site supervisor prior to delivery.
- B. All materials shall be stored in a designated area and protected from the environment.

- C. All materials shall be secured so as not to be a hazard during the construction process.
- D. All materials must be free of all dirt, debris and moisture during the installation process.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. BACKDRAFT DAMPERS:
 - a. Greenheck
 - b. Ruskin
 - c. Vent Products Company
 - d. or equal.
 - 2. FLEXIBLE CONNECTORS
 - a. Ductmate Industries
 - b. Ventfabrics, Inc.
 - c. Ward Industries
 - d. or equal.

2.2 SHEET METAL 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.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

- A. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
- B. Frame: 0.063-inch thick extruded aluminum, with welded corners and mounting flange.
- C. Blades: 0.050-inch thick aluminum sheet.
- D. Blade Seals: Neoprene.

- E. Blade Axles: Galvanized steel.
- F. Tie Bars and Brackets: Galvanized steel.
- G. Return Spring: Adjustable tension.

2.4 FLEXIBLE CONNECTORS

- A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- B. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.
- C. 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.
- D. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 1. Minimum Weight: 24 oz./sq. yd..
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.

PART 3 - EXECUTION

3.1 APPLICATION AND 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. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- E. Install fire dampers, with fusible links, according to manufacturer's UL-approved written instructions.
- F. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- G. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

3.3 DEMONSTRATION AND COMMISSIONING

- A. Demonstrate proper operation of equipment or designated owners personnel. The scope of the demonstration will include functional performance requirements under local control as well as any commissioning requirements in Division 1 or 15.
 - 1. For all fire dampers or access doors for fire dampers installed on this project the Contractor will demonstrate that any fire dampers selected by the owner can be dropped and reset using the provided access doors.
 - 2. Provide one demonstration and training session for duration of 2 hours.
 - 3. Coordinate with Pace the date and time of the training session.

END OF SECTION 15820

SECTION 16051 - 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 Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 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.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- 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.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - e. or equal
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Composite. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall 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 seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

END OF SECTION 16051

SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. This Section specifies equipment or systems, which will be commissioned as part of the construction process. The contractor will be required to provide documentation and testing of these systems. The Commissioning Authority will work in cooperation with the contractor to ensure compliance. Final Acceptance is dependent on successful completion of all commissioning procedures, documentation, and issue closure.

1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Building Code, Article 18-27-100, 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 City of Chicago Building Code (CCBC).

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 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.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
1. Bury at least 24 inches below grade.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 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.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. 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.
- C. Signal and Communication Equipment: In addition to grounding and bonding required by CCBC, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- 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.

3.4 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 (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 2. 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. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- F. 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.

3.5 LABELING

- A. Comply with requirements in Division 16 Section "Electrical Identification" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Manhole Grounds: 10ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect and Pace promptly and include recommendations to reduce ground resistance.

END OF SECTION 16060

INTENTIONALLY LEFT BLANK

SECTION 16073 - 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 Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 QUALITY ASSURANCE

- A. Comply with City of Chicago Building Code (CCBC).

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

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. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 2. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. 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 in which used.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 5. Toggle Bolts: All-steel springhead type.
 - 6. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by maximum spacings less than stated in CCBC. Minimum rod size shall be 1/4 inch in diameter.
- C. 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 single-bolt conduit clamps.

- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. 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 Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. 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 reinforcing bars.

3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 PAINTING

- A. Touchup: Comply with requirements in Division 9 painting Sections 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 A 780.

END OF SECTION 16073

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with City of Chicago Building Code (CCBC).
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

PART 2 - PRODUCTS

2.1 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE,.

C. Material:

1. 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, compounded for direct-burial service.
2. Overall Thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.5 WARNING LABELS AND SIGNS

- A. Comply with CCBC and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.6 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black except where used for color-coding.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 9 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

- I. Painted Identification: Comply with requirements in Division 9 painting Sections for surface preparation and paint application.

3.2 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.
 - c. 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. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.
- C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- D. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- F. 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 both direct-buried cables and cables in raceway.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.

- H. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, 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 systems unless equipment is provided with its own identification.
 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. 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. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - d. Enclosed switches.
 - e. Enclosed controllers.

END OF SECTION 16075

SECTION 16118 – UNDERGROUND DUCTBANKS AND RACEWAYS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, AND Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. Scope: The work specified in this section includes providing labor, material, equipment, and services necessary for work as shown on the drawings and as herein specified.
- B. Section Includes: The work specified in this section includes providing watertight cast-in-place concrete duct bank for utility service conductors both underground and within building structure.

1.3 DEFINITIONS

- A. Duct: Electrical conduit and other raceway used in the same trench or concrete envelope.
- B. Duct Bank: 2 or more conduits or other raceway installed in the same trench or concrete envelope.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract, Division 16 Specification Sections and Section 16051.
- B. Record Documents: Show locations and depths of ductbanks.
- C. Indicate material specifications, dimensions, capacities, and reinforcing details.
- D. Product Data: For the following:
 - 1. Accessories for manholes, handholes, boxes
 - 2. Duct entry provisions, including locations and duct sizes.
 - 3. Reinforcement details.
 - 4. Grounding details.
 - 5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 6. Joint details.
- E. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
- F. Source quality-control test reports.
- G. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Contractors Qualifications: Contractor with five years documented experience installing cast-in-place concrete structures in both underground and building applications (vertical ductbank).
- B. Comply with ANSI C2.
- C. Comply with City of Chicago Building Code (CCBC).

1.6 COORDINATION

- A. Coordination layout and installation of duct and manholes with final arrangement of other utilities, and other building trades.
- B. Coordinate elevations of duct and duct bank entrances into manholes and buildings with final profile of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated, with Pace's approval, as required to suite field conditions and ensure duct runs drain to manholes.
- C. Coordinate routing of vertical ductbank with architectural elements of building. Revise locations and elevations from these indicated, with architect and Pace's approval as required to suit field conditions.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to site with ends capped.
- B. Store precast concrete underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 COORDINATION

- A. Coordinate layout and installation of handholes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 – PRODUCTS

2.1 CONDUIT AND ACCESSORIES

- A. As indicated on drawings.
- B. Spacers: Plastic, to maintain spacing between conduits as detailed. Spacing, as a minimum, shall comply with the Chicago Electrical Code, figure 18-27-310.60.
- C. Bell Ends: Manufactured bell ends of approximate sizes at each end of conduit.
- D. Plugs: Closure plugs or caps of same material at ends of unused sections.
- E. Elbows: Rigid heavy wall galvanized steel with a minimum bend radius of 36 inches.

- F. Tie Wire: Nonferrous, to prevent displacement of the ducts and conduits during pouring of concrete. Do not use tie wires as substitutes for the spaces.
- G. Vertical Supports: As required for vertical ductbank.
- H. Pull Wire: 1/8" nylon pull rope in each empty duct.
- I. Grounding:
 - 1. Steel grounding bushings shall be grounded to manhole ground.
 - 2. Connect bonding strap to ground wire in manholes.
- J. Concrete Encasement:
 - 1. Concrete shall be as specified in Division 3.
 - 2. Encase duct as detailed on drawings. Top of duct shall be crowned to prevent puddling of water.
- K. Reinforcing Steel: Provide additional reinforcing steel at road crossings and parking lots. Extend rebar 5 feet past pavement. Coordinate such locations with Architect and Pace.

2.2 HANDHOLES AND BOXES

- A. Description: Comply with SCTE 77.
 - 1. Tier 22 rated.
 - 2. Color: Gray.
 - 3. Configuration: Units shall be designed for flush burial and have [open] [closed] bottom, unless otherwise indicated.
 - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 - 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm 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. Highline Products
 - c. Quazite, Hubbell Power Systems
 - d. or equal.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- 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. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.
 - 4. Oldcastle Precast Group.
 - 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - 6. Utility Concrete Products, LLC.
 - 7. Utility Vault Co.
 - 8. Wausau Tile, Inc.
 - 9. or equal.
- C. Comply with ASTM C 858 for design and manufacturing processes.
- D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
 - 1. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 3. Cover Legend: Molded lettering, As indicated for each service.
 - 4. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 - 5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 - 6. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
 - 1. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 – EXECUTION

3.1 EXCAVATION

- A. The Contractor is responsible for all demolition, excavation and backfilling required to install ductbanks.
- B. Excavate trenches for ductbank to adequate width, depth and proper slope as specified in Division 2.
- C. Install forms on sides of ductbank if trench is not of proper firmness to prevent cave-in.
- D. Bottom of trench shall be undisturbed earth. If trench bottom is too low for proper grade, fill to proper level with sand and mechanically compact it.

3.2 PLACEMENT OF CONDUIT

- A. Within five (5) feet of each down riser footing, concrete pad and manhole install heavy wall galvanized steel conduit within concrete envelope to provide protection against vertical shearing.
- B. Install spacers as recommended by conduit manufacturer and requirements stated above, but not to exceed a maximum of 6 feet on center for PVC conduit and 8 feet on center for steel conduit. Bottom spacers shall rest on 8" x 16" x 2" minimum concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover.
- C. Install insulated, grounding bushings on duct ends in equipment enclosure.
- D. Plug or cap empty conduits.
- E. Seal all spare ducts and conduits at terminations at equipment pedestals with a suitable compound to prevent entrance of moisture and gases.
- F. After ducts are in place, and before the concrete is poured, the installation shall be inspected by Pace. Notify Pace at least two days before the time of inspection.

3.3 PLACEMENT OF CONCRETE

- A. The Contractor shall supervise the placement of concrete in the ductbank.
- B. Place concrete as specified in Division 3. Top of concrete envelope shall not be less than 30 inches below finished grade.
- C. Place concrete from downriser to manhole, manhole to manhole and from manhole to transformer equipment pad without interruption.
- D. Conduits in completed ductbanks shall be straight to within ¼ inch per 100 feet in both vertical and horizontal directions.
- E. Duct bank concrete pours to be monolithic from termination to termination. If monolithic pours are not possible, joints are to be tapered and re-enforced as approved by Pace's representative.
- F. Pull mandrels and swabs (diameter ¼ inch smaller than conduit) through each conduit in completed ductbank before primary voltage cables are installed.

3.4 BACKFILL

- A. Install underground warning Tap 12 inches below finish grade over all ductbanks. Tape shall be red with the words "CAUTION – Electric Line Buried Below". Tape shall be Seton Catalog No. 210 or equal.

- B. Compact backfill around ductbanks in accordance with Division 2 specification.
- C. Restore areas to original conditions or as indicated on drawings after installation of ductbanks.

3.5 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less , Including Telephone, Communications, and Data Wiring:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3.6 EARTHWORK

- A. Excavation and Backfill do not use heavy-duty, hydraulic-operated, compaction equipment.

3.7 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Precast Concrete Handhole Installation:
 - 1. Comply with ASTM C 891, unless otherwise indicated.
 - 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
 - 1. Install handholes with bottom below the frost line, 40 inches below grade.
 - 2. Handhole Covers: Set surface flush with finished grade.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 16060 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

END OF SECTION 16118

SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, AND Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Building Code, Article 18-27-100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with City of Chicago Building Code (CCBC).

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Insulated Wire Corp.; a Leviton Company.
 - 2. General Cable Corporation.
 - 3. Senator Wire & Cable Company.
 - 4. Southwire Company.
 - 5. Encore Wire Corp.

6. or equal.

B. GTO Cable 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. Allied Wire & Cable
2. Hyrite
3. Omnicable
4. or equal.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.
6. or equal.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Feeders: Type THHN-THWN, single conductors in raceway .

C. Branch Circuits Type THHN-THWN, single conductors in raceway.

D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

E. Class 1 Control Circuits: Type THHN-THWN, in raceway.

F. Class 2 Control Circuits: Type THHN-THWN, in raceway .

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."
- F. Wiring in conduit shall be provided by the contractor.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. 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.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 16120

INTENTIONALLY LEFT BLANK

SECTION 16130 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, AND Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
 - 2. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.
 - b. Frame and cover design.
 - c. Grounding details.
 - d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - e. Joint details.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Building Code, Article 18-27-100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with City of Chicago Building Code (CCBC).

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. IMC: ANSI C80.6.
- C. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- D. EMT: ANSI C80.3.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: compression type with insulated throat.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.
- H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- B. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.
4. Allied Tube & Conduit; a Tyco International Ltd. Co.
5. or equal.

- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type.
- E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect and Pace.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division
 - d. or equal.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 2. EGS/Appleton Electric.
 3. Erickson Electrical Equipment Company.
 4. Hoffman.
 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 6. O-Z/Gedney; a unit of General Signal.
 7. RACO; a Hubbell Company.
 8. Thomas & Betts Corporation.
 9. Walker Systems, Inc.; Wiremold Company (The)
 10. or equal.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

- F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- G. Hinged-Cover Enclosures: 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.
- 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.
 - 5. Accessory feet where required for freestanding equipment.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
 - 1. Color of Frame and Cover: Gray.
 - 2. Configuration: Units shall be designed for flush burial and have integral closed 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, as indicated for each service.
 - 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 7. Handholes 36 inches wide by 36 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with 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. CDR Systems Corporation.
 - d. NewBasis.
 - e. Quazite
 - f. or equal.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: Rigid steel conduit.
3. Underground Conduit, Not Subject to Vehicular Traffic: Rigid steel conduit, direct buried.
4. Underground Conduit, Subject to Vehicular Traffic: Rigid steel conduit or RNC, type EPC-40-PVC, concrete-encased.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
7. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: , SCTE 77, Tier 15 structural load rating.
 - b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: SCTE 77, Tier 8 structural load rating.
 - c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit.
7. Within Concrete Slabs Above Grade: EMT with concrete-tight fittings.
8. Within or Below Slab on Grade: Rigid steel conduit.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 16 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- I. 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.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. 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.
- L. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by CCBC.
- M. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, 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 in damp or wet locations not subject to severe physical damage.
- N. 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.
- O. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 2 Section "Earthwork."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For stub-ups at 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.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 16130

INTENTIONALLY LEFT BLANK

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, AND Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Wall-box motion sensors.
 - 4. Isolated-ground receptacles.
 - 5. Snap switches and wall-box dimmers.
 - 6. Wall-switch occupancy sensors.
 - 7. Pendant cord-connector devices.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in City of Chicago Building Code, Article 18-27-100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- C. Comply with City of Chicago Building Code (CCBC).

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 3. Leviton Mfg. Company Inc. (Leviton).
 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour)
 5. or equal.

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 1. Back and side wired.
 2. Specification grade, heavy-duty type.
 3. High impact, chemical resistant smooth nylon face.

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 1. Back and side wired.
 2. Specification grade, heavy-duty type.
 3. High impact, chemical resistant smooth nylon face.

2.4 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.5 SNAP SWITCHES

- A. General Description: Comply with NEMA WD 1 and UL 20.
 - 1. Back and side wired, terminals to accept up to #10AWG wire.
 - 2. Specification grade, heavy-duty type.
 - 3. Ground screw terminal.
- B. Switches, 120 V, 20 A
- C. Pilot Light Switches, 20 A
 - 1. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
- D. Key-Operated Switches, 120 V, 20 A
 - 1. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120 V, 20 A; for use with mechanically held lighting contactors.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.6 WALL-BOX DIMMERS

- A. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472. Separate controls for dimming and on-off.
- B. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 10 percent of full brightness.

2.7 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Sensor Switch; WSD-PDT-SA
 - b. or equal.
 - 2. Description: Adaptive-technology type, 120 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
- B. Long-Range Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Sensor Switch; WSD-PDT-SA
 - b. or equal.

2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft. (111 sq. m).

C. Wide-Range Wall-Switch Sensors:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Sensor Switch; WSD-PDT-SA
 - b. or equal.
2. Description: Passive-infrared type, 120 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft. (111 sq. m).

2.8 WALL PLATES

- A. Single and combination types to 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.
 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.9 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, 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, unless otherwise indicated.
- E. Voice and Data Communication Outlet: as indicated on Drawings.

2.10 HAND DRYER

- A. Manufacturer: Bradley, model 2922-287300 or equal 1500W model.
- B. Installation: Hand dryer shall be installed per manufacturer's installation manual.

2.11 MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.

2. Wiremold Company (The)
 3. or equal.
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: No. 12 AWG.

2.12 FINISHES

- A. Color
1. Wiring Devices Connected to Normal Power System: As selected by Architect and Pace, unless otherwise indicated or required by CCBC or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red.
 3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. 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 the boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
1. Do not strip insulation from conductors until just 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 CCBC, 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. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they 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 (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 16 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 16140

INTENTIONALLY LEFT BLANK

SECTION 16145 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, AND Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Indoor occupancy sensors.
 - 2. Programmable, digital lighting controls with external signal source, relays and control module.
- B. Related Sections include the following:
 - 1. Division 16 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.
- C. BACnet: A networking communication protocol that complies with ASHRAE 135.
- D. BAS: Building automation system.
- E. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- F. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- G. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- H. PC: Personal computer; sometimes plural as "PCs."
- I. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
- J. RS-485: A serial network protocol, similar to RS-232, complying with TIA-485-A.
- K. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
- C. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Building Code, Article 18-27-100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with City of Chicago Building Code (CCBC).

1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period. All warranties shall clearly define the specific coverage (e.g. parts and labor required), components covered, period of warranty, and commencement period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of software input/output to execute switching or dimming commands.
 - b. Failure of modular relays to operate under manual or software commands.
 - c. Damage of electronic components due to transient voltage surges.
 - 2. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
 - 3. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

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

1. Area Lighting Research, Inc.; Tyco Electronics.
 2. Grasslin Controls Corporation; a GE Industrial Systems Company.
 3. Intermatic, Inc.
 4. Paragon Electric Co.; Invensys Climate Controls.
 5. TORK
 6. or equal.
- B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
 2. Time Delay: 15-second minimum, to prevent false operation.
 3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Sensor Switch, Inc.
 2. or equal.
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. 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.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

- C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
 - 1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
 - 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.
 - 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot high ceiling.

- D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
 - 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s .
 - 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch high ceiling.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.
 - 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch high ceiling.
 - 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot high ceiling in a corridor not wider than 14 feet.

- E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

2.3 ELECTRONIC LIGHTING RELAY PANELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Leviton Mfg. Company Inc.
 - 2. Lightolier Controls; a division of Genlyte Group, LLC.
 - 3. Lutron Electronics Co., Inc.
 - 4. or equal.

2.4 SYSTEM REQUIREMENTS

- A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.

- B. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to an integrated relay panel that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.

2.5 CONTROL MODULE

- A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Unit shall be networked for control of indicated number of output circuits. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices, all located in other enclosures. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD shall display manual-control and programming steps. Modules and their associated control panels shall include the following features:
 - 1. Multiple inputs and multichannel output arranged for 8-48 channels.
 - 2. Multiple inputs for indicated occupancy sensors and hand-held programming device.
- B. Display: Separate graphic displays for programming each lighting control panelboard.
- C. Interoperability: Control module shall be configured to connect with other control systems using RS-485 network to enable remote workstations to use control module functions.
- D. Interoperability: Control module shall be configured to connect to BACnet-compliant network, resulting in extending control to any network-compliant devices such as occupancy switches.
- E. System Memory: Nonvolatile. System shall reboot program and reset time automatically without errors after power outages up to 90 days' duration.
- F. Software: Lighting control software shall be capable of linking switch inputs to relay outputs, retrieving links, viewing relay output status, controlling relay outputs, simulating switch inputs, setting device addresses, and assigning switch input and relay output modes.
- G. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight saving time and shall provide weekly routine and annual holiday scheduling.
- H. Astronomic Control: Automatic adjustment of dawn and dusk switching.
- I. Demand Control: Demand shall be monitored through pulses from a remote meter and shall be controlled by programmed switching of loads. System capability shall include sliding window averaging and programming of load priorities and characteristics. Minimum of two different time-of-day demand schedules shall execute load-management control actions by switching output circuits or by transmitting other types of load-control signals.
- J. Confirmation: Each relay or contactor device operated by system shall have auxiliary contacts that provide a confirmation signal to the system of on or off status of device. On or off status confirmation for each electrically operated circuit breaker shall be provided by an auxiliary contact or by a sensing device at load terminal.
- K. Software shall interpret status signals, provide for their display, and initiate failure signals.

- L. Lamp or LED at control module or display panel shall identify status of each controlled circuit.
- M. Remote Communication Capability: Allow programming, data-gathering interrogation, status display, and controlled command override from a PC at a remote location over data links. System shall include modem, communications and control software, and remote computer compatibility verification for this purpose.
- N. Local Override Capability: Manual, low-voltage control devices shall override programmed shutdown of lighting and shall override other programmed control for intervals that may be duration programmed.
- O. Automatic Control of Local Override: Automatic control shall switch lighting off if lighting has been switched on by local override.
- P. Automatic battery backup shall provide power to maintain program and system clock operation for 90 days' minimum duration when power is off.
- Q. Programmed time signals shall change preset scenes and dimmer settings.
- R. Daylight Balancing Dimming Control: Control module shall interpret variable analog signal from photoelectric sensor and shall route dimming signals to dimming fluorescent ballast control circuits. Signal shall control dimming of fixture so illumination level remains constant as daylight contribution varies.
- S. Daylight Compensating Switch Control: Control module shall interpret a preset threshold illumination-level signal from a photoelectric relay and shall activate relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.
- T. Energy Conservation: Bilevel control of special ballasts or dimming circuits to comply with local energy codes.
- U. Flick Warning: Programmable momentary turnoff of lights shall warn that programmed shutoff will occur after a preset interval. Warning shall be repeated after a second preset interval before end of programmed override period.
- V. Diagnostics: When system operates improperly, software shall initiate factory-programmed diagnosis of failure and display messages identifying problem and possible causes.

2.6 POWER DISTRIBUTION COMPONENTS

- A. Modular Relay Panel: Comply with UL 508 (CAN/CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
- B. Cabinet: Steel with hinged, locking door.
 - 1. Barriers separate low-voltage and line-voltage components.
 - 2. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
 - 3. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
- C. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.

1. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
 2. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
 3. Endurance: 50,000 cycles at rated capacity.
 4. Mounting: Provision for easy removal and installation in relay cabinet.
- D. Line-Voltage Surge Suppression: Factory installed as an integral part of 120V ac, solid-state control panels.

2.5 DIGITAL PUSHBUTTON SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary-contact, low-voltage type, with up to 6 buttons per switch location.
1. Match color specified in Division 16 Section "Wiring Devices."
 2. Integral green LED pilot light to indicate when circuit is on.
 3. Internal white LED locator light to illuminate when circuit is off.
 4. Provide key-operated digital switches as indicated on drawings.
- B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 16 Section "Wiring Devices."
- C. Wall Plates: Single and multigang plates as specified in Division 16 Section "Wiring Devices."
- D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 18 AWG.
- C. Class 1 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. 14AWG.
- D. Structured Network Digital and Multiplexed Signal Cables: UTP cable with copper conductors, complying with TIA/EIA-568-B.2, Category 6for horizontal copper cable.
- E. RS-485 Cables:
1. Standard Cable: NFPA 70, Type CMor CMG.
 2. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 3. PVC insulation.
 4. Unshielded.
 5. PVC jacket.
 6. Flame Resistance: Comply with UL 1581.
 7. Plenum-Rated Cable: NFPA 70, Type CMP.
 8. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 9. Fluorinated ethylene propylene insulation.
 10. Unshielded.
 11. Fluorinated ethylene propylene jacket.

12. Flame Resistance: NFPA 262, Flame Test.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install wiring in raceways to comply with Division 16 Section "Conductors and Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- E. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- F. Provide communications cables according to manufacturer's written instructions.
- G. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
- H. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."
 1. Identify controlled circuits in lighting relay panel.

3.3 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. Tests and Inspections:
 1. Test for circuit continuity.
 2. Verify that the control module features and sensors are operational.
 3. Check operation of local override controls.
 4. Test system diagnostics by simulating improper operation of several components selected by Architect and Pace.
- C. Lighting controls will be considered defective if they do not pass tests and inspections.

3.4 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

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.

3.6 DEMONSTRATION

- A. Train Pace' maintenance personnel to adjust, operate, and maintain lighting controls and devices (minimum 4 hour duration)

END OF SECTION 16145

INTENTIONALLY LEFT BLANK

SECTION 16410 - 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 Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Building Code, Article 18-27-100, by a qualified testing agency, and marked for intended location and application.
- C. Comply with City of Chicago Building Code (CCBC).

1.6 PROJECT 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 (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric
 - 5. or equal.
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- D. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. 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. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 6. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 7. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric
 - 5. or equal.
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac, 200 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.
- D. Type HD, Heavy Duty, Double 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.
- E. 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. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS – NOT USED OUTSIDE OF PANELBOARDS

2.4 MOLDED-CASE SWITCHES – NOT USED

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 .

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 16 Section "Electrical Identification."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 16 Section "Overcurrent Protective Device Coordination".

END OF SECTION 16410

INTENTIONALLY LEFT BLANK

SECTION 16420 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, AND Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and installed components.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Building Code, Article 18-27-100, by a qualified testing agency, and marked for intended location and application.
- B. Comply with City of Chicago Building Code (CCBC).

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers. .

1.7 PROJECT 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 (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).

1.8 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Fractional Horsepower Manual Controllers: "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 Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D; a brand of Schneider Electric
 - e. or equal.
 - 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.
 - 4. Surface mounting.
 - 5. Red pilot light.

- C. Integral Horsepower Manual Controllers: "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 Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D; a brand of Schneider Electric
 - e. or equal.
 - 2. Configuration: Nonreversing .
 - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button.
 - 4. Surface mounting.
 - 5. Red pilot light.

2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 3R .
 - 3. Kitchen Areas: Type 4X, stainless steel.
 - 4. Other Wet or Damp Indoor Locations: Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
 - 6. Hazardous Areas Indicated on Drawings: Type 7 .

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise 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 Division 16 Section "Hangers and Supports for Electrical Systems."

- B. Install fuses in control circuits if not factory installed.
- C. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- D. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Pace before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION 16420

INTENTIONALLY LEFT BLANK

SECTION 16442 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Owner utility metering.

1.3 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. 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.
- C. Panelboard Schedules: For installation in panelboards.
- D. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Building Code, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with City of Chicago Building Code (CCBC).

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards or utility meter 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 (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards, utility meter, 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.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

1.9 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. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4 .
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
 - 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 - 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

5. Split Bus: Vertical buses divided into individual vertical sections.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Adjustments for Oversized Conductors: Provide suitable means to terminate conductor sizes and quantities for supply and load feeders indicated on the drawings, including but not limited to larger lugs, buses, or overcurrent protective device frame sizes.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 EQUIPMENT FOR ELECTRICITY METERING BY PACE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
 5. Erickson
 6. or equal.
- B. General Requirements for Pace's Meters:
1. Comply with UL 1244.
 2. Meters used for billing shall have an accuracy of 0.2 percent of reading, complying with requirements in ANSI C12.20.
 3. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.
 4. Identification: Comply with requirements in Division 16 Section "Electrical Identification."
 5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
 6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
 - a. Type: Split and solid core.
 7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
- C. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

2.3 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
 5. Erickson
 6. or equal.
- B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- C. Mains: Circuit breaker
- D. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on or Plug-in circuit breakers.
- E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric
 5. or equal.
- 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 Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric
 5. or equal.
- B. 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-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 6. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - i. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - j. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - k. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
 2. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- C. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- H. Comply with NECA 1.
- I. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- J. Install modular meter center according to NECA 400 switchboard installation requirements.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 16 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads; incorporate Paces final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 16 Section "Electrical Identification."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 16 Section "Electrical Identification."

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. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections (Panelboards):
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Panelboards will be considered defective if they do not pass tests and inspections.
- D. Tests and Inspections (Utility Meter):
 - 1. Connect a load of known kilowatt rating 1.5 kW minimum, to a circuit supplied by metered feeder.
 - 2. Turn off circuits supplied by metered feeder and secure them in off condition.
 - 3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
 - 4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
 - 5. Electricity metering will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards and utility meter included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 16 Section "Overcurrent Protective Device Coordination."

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 16442

INTENTIONALLY LEFT BLANK

SECTION 16511 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, AND Instructions to Bidders apply to this and the other sections of Division 16.

1.2 SUMMARY

- A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

- B. Related Sections:

1. Division 16 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
2. Division 16 Section "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. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LED: Light Emitting Diode
- F. LER: Luminaire efficacy rating.
- G. Lumen: Measured output of lamp and luminaire, or both.
- H. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including BF.
4. Energy-efficiency data.
5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

a. **Manufacturer Certified Data:** Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. **Shop Drawings:** For nonstandard or custom lighting fixtures. 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.

C. Installation instructions.

D. Field quality-control reports.

E. **Operation and Maintenance Data:** For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

F. **Warranty:** Sample of manufacturer's warranty.

1.5 QUALITY ASSURANCE

A. **Luminaire Photometric Data Testing Laboratory Qualifications:** Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in Chicago Building Code, Article 18-27-100, by a qualified testing agency, and marked for intended location and application.

C. Comply with City of Chicago Building Code (CCBC).

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Manufacturer's Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: Two Years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 - 2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Two years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Exhibit I, Lighting Fixture Schedule, or equal.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- H. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.

- I. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 1. Label shall include the following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.

2.3 POWER SUPPLIES FOR LED

- A. Description: Ballast shall be UL listed and have low-voltage magnetic dimming capabilities with secondary protection:
 1. Sound Rating: Class A.
 2. Total Harmonic Distortion Rating: Less than 20 percent.
 3. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 4. BF: 0.95 or higher unless otherwise indicated.
 5. Power Factor: 0.95 or higher.
 6. See "Ballasts" Article in the Evaluations for discussion on CFR compliance required in subparagraph below.
 7. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 1. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

- f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
- g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is announced by an integral audible alarm and a flashing red LED.

2.5 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 - 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 - 8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - 9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is announced by an integral audible alarm and a flashing red LED.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 16 Section "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 fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.7 LED LUMINAIRES

- A. Manufacturers: LED Lamps (PCB), provide LED specified in lighting fixture schedule (or equal, subject to approval, that meet or exceed the performance specifications).
- B. LED Luminaires: Minimum CRI 75, CCT range within +/-250K of specified CCT on lighting fixture schedule, average life of 50,000+ hours tested at IESNA LM-80-2008 for 70% lumen output or greater.
- C. LED Lamp (PCB) data shall include:
 - 1. Color—dominant wavelength (nm) and method of color mixing.
 - 2. Distribution range (degrees).
 - 3. Quantity of LEDs per PCB (or unit length, where applicable).
 - 4. Lumen rating of fixtures per IESNA LM-70 testing.
 - 5. Required current, voltage and maximum input watts.
 - 6. Limitations on wiring configurations or maximum PCB current rating.
- D. LED luminaires shall meet LED lamp manufacturer's recommendations for:
 - 1. Thermal dissipation
 - 2. Operating temperature range for both the LED and Power Supply.
 - 3. Storage temperature range for both the LED and Power Supply.
 - 4. Operating voltage and current.
 - 5. Peak pulse forward current.
- E. LED fixture manufacturers shall provide a driver (power supply) that supplies stable DC current with voltage range covering the forward voltage as well as variability.
- F. Fixtures shall be constructed to allow for the PCB, driver, and electrical components to be easily accessed and replaced without being removed from the mountings or disassembled adjacent construction.
- G. LEDs and fixture components (including fixtures for wet/damp location) shall be listed by a nationally recognized testing laboratory such as UL, ETL or CUL.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

- C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- E. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Connect wiring according to Division 16 Section "Conductors and Cables."

3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."

3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Pace. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect and Pace.

END OF SECTION 16511



January 17, 2011

Ms. Pat Barker, PE, CFM
Senior Project Manager
Robinson Engineering, LTD
17000 South Park Avenue
South Holland, Illinois 60473

Re: Geotechnical Engineering Report
PACE Bus Station
Toyota Park
7300 West 71st Street
Bridgeview, Illinois
GEOCON Project No. 11-G660

Dear Ms. Barker:

Pursuant to our proposal for geotechnical engineering services, we have completed a subsurface exploration and geotechnical analyses for the above referenced project. This electronic copy of the Geotechnical Engineering Report includes our findings and recommendations for the proposed project referenced above. Please contact our office if you require hard copies of the report.

GEOCON Professional Services, Inc. (GEOCON) appreciates the opportunity to be of service during this phase of the project. If there are any questions or comments you may have regarding the contents of this report, or if we may be of any further service, please contact us at your convenience.

Sincerely,

GEOCON Professional Services, LLC.

A handwritten signature in black ink, appearing to read "Kenneth K. Rippy".

Kenneth K. Rippy, PE
Principal Geotechnical Engineer

A handwritten signature in black ink, appearing to read "Gregory J. Renshaw".

Gregary J. Renshaw, PE
Senior Geotechnical Engineer





Geotechnical Engineering Report

**PACE Bus Station
Toyota Park
7300 West 71st Street
Bridgeview, Illinois**

**Ms. Pat Barker, PE, CFM
Senior Project Manager
Robinson Engineering, LTD
17000 South Park Avenue
South Holland, Illinois 60473**

**Prepared By:
GEOCON Professional Services, LLC.
9370 West Laraway Road, Suite D
Frankfort, Illinois 60423**

January 17, 2012

GEOCON Project No. 11-G660

TABLE OF CONTENTS

	Page
INTRODUCTION	1
PROJECT AND SITE DESCRIPTION	1
SUBSURFACE EXPLORATION	1
Drilling and Sampling Procedures	1
Laboratory Tests	2
SOIL CONDITIONS	2
GROUNDWATER CONDITIONS	3
ENGINEERING RECOMMENDATIONS	3
Foundations	3
Settlement Analysis	4
Resistance to Lateral Loads	4
Lateral Earth Pressures	4
Site Preparation and Earthwork	5
Controlled Compacted Fill	6
Slabs-on-Grade	6
CONSTRUCTION CONSIDERATIONS	7
Groundwater Control	7
Excavations	7
GENERAL COMMENTS	7
APPENDIX	
Figure 1 – Site Vicinity Map	
Figure 2 – Boring Location Diagram	
Soil Boring Logs	
General Notes	

**GEOTECHNICAL ENGINEERING REPORT
PACE BUS STATION
TOYOTA PARK
7300 WEST 71ST STREET
BRIDGEVIEW, ILLINOIS**

INTRODUCTION

This report presents the results of a subsurface exploration for the proposed PACE Bus Station, located at Toyota Park, 7300 West 71st Street, in Bridgeview, Illinois. The purpose of this report was to determine and evaluate the subsurface conditions existing at the subject site, and to establish related geotechnical parameters to be utilized for the economical design and construction of the foundations and floor slab for this project.

Authorization to perform this subsurface exploration and analysis was provided in the form of an email authorization received from Ms. Pat Barker, PE, CFM of Robinson Engineering, LTD. (REL). The email authorization was received on December 22, 2011 and was based on GEOCON Proposal No. 11-P531, dated October 26, 2011. The above referenced proposal described the project scope and contained general conditions for performance of the work.

PROJECT AND SITE DESCRIPTION

The proposed project consists of constructing a new PACE Bus Station structure located at Toyota Park, 7300 West 71st Street in Bridgeview, Illinois. Specifically, the new building will be located in the southern portion of the Toyota Park parking lot, between existing gate entrances S3 and S4. The new building will be a single story slab on grade structure and will occupy an area with plan dimensions about 25 feet by 275 feet. Structure loads were not provided but they are anticipated to be relatively light with maximum column loads of about 75 kips. The existing surface is paved with asphalt, and grades in the area of the building are relatively flat, indicating that only minor mass grading will be required to prepare the site for construction.

SUBSURFACE EXPLORATION

The scope of the exploration, including the number, location and depth of the borings, was determined by REL as specified in their Request for Proposal (RFP) for Geotechnical Services. A total of 2 borings were advanced for the project at the approximate locations shown on the Boring Location Diagram labeled Figure 2, included in the Appendix. The borings were advanced to a predetermined termination depth of 30 feet below grade. The boring locations were staked in the field by REL prior to drilling, and ground surface elevations at the boring locations were provided by REL.

After completion of the borings, the holes were backfilled with soil cuttings and patched with like materials as encountered at the boring. This procedure was performed for safety purposes and precluded the recording of delayed water level readings.

Drilling and Sampling Procedures

The soil borings were performed with a truck-mounted drilling rig equipped with a rotary head. Conventional, continuous flight, hollow-stem augers were used to advance the borings with representative samples obtained in each boring employing split-barrel sampling techniques in

accordance with ASTM Procedure D-1586. Soil samples were secured at 2.5 foot intervals to a minimum depth of 10 feet below ground surface, followed by 5 foot sample intervals to the termination depth of the borings.

The Standard Penetration Test (SPT) is defined as the number of blows required to advance a 2 inch O.D., split-barrel sampler a distance of one foot by a 140 pound hammer falling 30 inches, commonly described as the N-value. These sampler resistances provide a useful indication of the consistency or relative density of most soil deposits and are reported on the boring logs presented in the Appendix. Samples of cohesive soils obtained from the borings were tested with a calibrated hand penetrometer to aid in evaluating the soil strength characteristics. The results from this testing is tabulated on the boring logs.

Water level observations were made during drilling operations. This data is noted on the boring logs.

Laboratory Tests

Additional characteristics of the foundation materials were determined in the laboratory to provide data on which to classify and estimate the engineering properties of the subsurface soil deposits encountered in the borings. All samples were visually classified by the geotechnical engineer according to the Unified Soil Classification System (ASTM D-2488). An explanation of the symbols used in this system is included in the Appendix.

Representative samples were tested in the laboratory to determine the natural moisture content of the soils. All moisture contents are expressed as a percentage of the dry weight of soil. Representative samples of the cohesive soils encountered in the borings were tested in the laboratory with a calibrated RIMAC spring tester to determine the approximate unconfined compressive strength of the soil samples.

The laboratory testing program selected for this project is intended to assist with determination of soil classification as well as strength and deformation characteristics of the subsurface soil deposits that will provide foundation support for the proposed structures. All laboratory testing was performed in general accordance with the respective ASTM Methods, as applicable, and the results are included on the boring logs and laboratory test reports included in the Appendix. Unless notified to the contrary, all samples will be disposed of after one month.

SOIL CONDITIONS

The types of foundation materials encountered at the test boring locations are described on the Soil Boring Logs. The lines delineating the changes in strata on the logs represent an approximate boundary between the various soil classifications. It must be recognized that the soil descriptions are considered representative for the specific test hole location, but the variations may occur between the sampling intervals and boring locations. A summary of the major soil profile components is described in the following paragraphs. A more detailed description and supporting data for each boring location can be found on the individual boring logs.

The borings encountered a surficial layer of asphalt that ranged in thickness from about 6 to 8 inches, followed by aggregate base material about 8 to 10 inches thick. The pavement was underlain by cohesive silty clay soil that extended to the termination depths of the borings at 30 feet below surface grade. The upper silty clay was brown and grey mottled in color, and was generally described as hard with unconfined compressive strengths ranging from 4.5 to 6.6 tons per square foot (tsf) and moisture contents ranged from 18.9 to 20.7 percent. The brown and grey mottled silty

clay stratum extended to a depth of about 9 feet below grade and was underlain by grey silty clay that extended to the boring termination depth of 30 feet below grade. The grey silty clay was described as very stiff to hard with unconfined compressive strengths ranging from 3.4 to 10.4 tsf and moisture contents ranged from 13.1 to 18.9 percent.

GROUNDWATER CONDITIONS

Groundwater was not encountered while drilling and the borings were dry upon completion at the cave depths ranging from 16 to 18 feet below grade. It should be noted that due to the relatively limited stabilization times under which the water levels measurements were made, these observed groundwater level readings may not indicate the static water level for the site. In addition, groundwater levels fluctuate over time and are influenced by seasonal precipitation and varying permeability characteristics of the subsurface soils.

ENGINEERING RECOMMENDATIONS

Foundations

Based on the soil conditions encountered during the subsurface investigation and laboratory test results, conventional spread footings and continuous wall footings may be used to support the planned building. Spread footing foundations may be placed directly on the natural brown and/or grey silty clay with a minimum unconfined compressive strength of 2.0 tsf, and can be designed for a net allowable bearing pressure of 4,000 pounds per square foot (psf). The net allowable soil bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation.

Field observation of the foundation subgrade soil should be performed by a representative of the geotechnical engineer at the time of construction. At a minimum, the foundation observation and testing program should include visual inspection of the foundation excavations prior to concrete placement, to verify material type and confirm that any loose or otherwise disturbed soil has been removed from the excavation. Dynamic Cone Penetrometer (DCP) and hand penetrometer testing of cohesive soil should be performed to verify that the natural silty clay present within the influence zone of the foundations exhibits a minimum unconfined compressive strength of 2.0 tsf.

Lower strength bearing soils present within the influence zone of the foundation systems, that do not meet the minimum strength requirements described above, should be densified or removed and replaced with select granular material, such as IDOT CA-6 or equivalent, or lean concrete. Where the removal and replacement of unsuitable bearing material is performed beneath proposed footings, if select granular material is used as backfill, the undercut must extend laterally beyond the perimeter of the foundation for a distance at least equal to the thickness of the backfill below the footing base. If lean concrete is used as the backfill material, the footing excavations would not need to be significantly widened. If select granular material is used as backfill for undercuts below proposed spread footings, the fill placement and compaction recommendations provided in the Controlled Compacted Fill section of this report should be followed.

Regardless of contact pressure, individual column footings should have a minimum dimension of 24 inches, and continuous footings a minimum width of 18 inches. It is recommended that exterior footings be placed at a minimum depth of 3.5 feet below the finished grade for frost protection purposes. Due to the periodic severity of winters in this area, it is also suggested that footings in poorly heated or unheated areas of the building be placed at least 3.5 feet below the adjacent exterior grade. Interior footings not susceptible to frost action may be founded immediately below

the floor slab, provided they bear on suitable natural soils or controlled compacted fill placed as described in this section. All footings must be protected from the effects of frost if construction is carried out during winter months.

Settlement Analysis

The results of the field and laboratory testing were used to estimate settlement of the proposed foundations. Correlations between physical soil index properties such as moisture content, Standard Penetration N-values, and compressibility parameters, were used in the analyses. It is our opinion that foundation settlement will be within tolerable limits (less than 1 inch) if the recommended design and construction criteria are followed. It is recommended that the construction of foundations be monitored and tested by a representative of the geotechnical engineer.

Resistance to Lateral Loads

Shallow foundations develop resistance to lateral loads primarily from frictional resistance at the base of the foundation, and by the passive resistance against the soil adjacent to the foundation. The frictional resistance can be calculated using a coefficient of friction of 0.35 provided that the calculated value does not exceed the shear strength of the clay soil where present, which for this case may be taken as 2,000 psf. For the purposes of resisting lateral loads, passive resistance on the side of the foundation can be considered to be 280 psf per foot of depth below the ground surface.

The capacities provided above are ultimate values and it is recommended that a minimum factor of safety of 1.5 be used to arrive at allowable values of lateral resistances for shallow foundations.

Lateral Earth Pressures

Below grade walls should be designed to resist lateral earth pressures from the backfill soils. Lateral earth pressures that act on walls vary depending on several factors, including structural wall design, character of fixity and condition and type of wall backfill. Walls are typically designed for one of two conditions: free-standing cantilever, which assumes slight wall rotation or deflection, and "at-rest", which assumes no wall rotation or deflection.

The following table provides the recommended minimum lateral earth pressures for design of the basement walls.

Earth Pressure Condition	Backfill Type and Coefficient	Equivalent Fluid Pressure* (pcf)	Surcharge Pressure (psf)	Earth Pressure* (psf)
Active (Ka)	Granular: 0.33	40	0.33 (q)	40 (z)
	Cohesive: 0.42	50	0.42 (q)	50 (z)
At-Rest (Ko)	Granular: 0.5	60	0.5 (q)	60 (z)
	Cohesive: 0.6	72	0.6 (q)	72 (z)

Passive (Kp)	Granular: 3.0	360	--	--
	Cohesive: 2.4	288	--	--

*Assumes soil backfill unit weight of 120 pcf.

* Where (q) is a uniform surcharge load applied at the top of the wall (such as additional overburden above the top of the wall), and (z) is the depth to the point of action of the lateral pressure.

The values in the above table do not include factors of safety, which should be applied to passive pressures that are relied on to resist applied loads. The surcharge pressure should be used to estimate lateral loads imposed on the walls from materials, overburden soils, structures, equipment, traffic loads and construction equipment located within a horizontal distance from the wall equal to the depth of the wall below grade. Potential surcharge loads for the life of the wall should be accounted for in the wall design.

No provision for hydrostatic pressures due to the presence of water are included in the values in the table above. It is recommended that perimeter drain system be used wherever possible to minimize the possibility of hydrostatic loading on below-grade walls. In addition, free-draining granular material should be placed adjacent to the below grade walls and above the drain lines to within 1.5 ft. of final grade. Compacted cohesive fill should be placed above the granular material to minimize infiltration of surface water into the drain system.

If a permanent drainage system is not included in the design, hydrostatic pressures should be included in the wall design and an impermeable membrane should be installed prior to backfilling to resist seepage into the basement. For combined hydrostatic and lateral earth forces, equivalent fluid pressures of 87 and 97 pcf should be used for the active and "at-rest" conditions, respectively, using cohesive backfill; and equivalent fluid pressures of 82 and 91 pcf should be used for the active and "at-rest" conditions, respectively, using granular backfill.

Site Preparation and Earthwork

Existing utilities that interfere with the proposed construction should be properly relocated or removed and the trenches backfilled as described herein. Mass grading planned for this project will primarily consist maximum cut or fill estimated to be in the range of 0 to 2 feet.

In general, floors may be supported on the existing subgrade soils provided that field evaluation is conducted to verify the subgrade is firm and does not contain excessive organic matter or other deleterious material. After cutting to design subgrade and prior to placement of new fill or granular base course material, it is recommended that the exposed subgrade soil be thoroughly proofrolled in order to identify any weak or unsuitable areas at or just below the subgrade elevation. Proofrolling may be accomplished with a fully loaded single axle dump truck or other pneumatic tire equipment which provides a similar subgrade loading. Areas that experience rutting or pumping under the proofroll load should be improved by scarification, air drying and recompaction, or by undercutting and replacement with suitable compacted fill. Low areas may then be raised to the planned grades with suitable, properly compacted fill as described in the following section.

The existing subgrade soils will be susceptible to disturbance from precipitation, construction traffic and vibrations. Care should be taken to avoid disturbance of the subgrade soil and construction traffic over prepared subgrades should be avoided. If the subgrade soils become disturbed during construction, they should be scarified and recompacted or removed and replaced prior to placing new site grading fill or granular subbase material.

Mass grading and earthwork operations should be observed and evaluated by a representative of the geotechnical engineer.

Controlled Compacted Fill

It is recommended that fill materials used for structural support in the building and pavement areas consist of non-organic lean clay or well-graded granular soils, free of organic matter or other deleterious material. The silty clays encountered in the borings generally appeared to be suitable for reuse as fill material, but may require moisture conditioning prior to use. Further evaluation of the suitability of the on-site materials, including Atterberg limits, organic content and laboratory Proctor tests, should be performed at the time of construction.

All structural fill should be placed on firm subgrades, and the fill should be placed in lifts and properly compacted. All newly placed fill within 10 feet of the building footprint or in new pavement areas should be placed in 9 inch or less loose lifts and compacted to at least 95 percent of the maximum dry density as determined by ASTM D-698 (Standard Proctor) method of test. The fill should be placed within +/- 2 percent of the optimum moisture content value determined by laboratory Proctor testing. The minimum density requirement could be reduced to 90 percent of the maximum dry density as determined by ASTM D-698 (Standard Proctor) when placing fill in landscape areas greater than 10 feet outside the building footprint.

Backfill placed in utility excavations or against foundation walls should consist of a well-graded granular material. Proper placement and compaction of backfill in these areas is considered essential in order to reduce the potential for distress of overlying pavements and floor slabs. The placement of backfill against unsupported walls may induce movement, particularly where the backfill is placed on one side of the wall to a higher elevation than the backfill on the other side. Small, hand-operated compactors should be used in confined areas.

The site should be graded to promote runoff of surface water in order to minimize ponding of precipitation on the prepared subgrades, or in excavations. If the subgrade becomes saturated, or becomes deteriorated from repeated construction traffic, the affected material should be removed and these materials should be disked and recompactd or undercut and replaced with suitable fill prior to further construction in those areas.

GEOCON recommends that the evaluation of the subgrade and selection of fill materials for various applications should be done in consultation with the geotechnical engineer, and placement of fill for structural applications be monitored and tested by a representative of the geotechnical engineer.

Slabs-on-Grade

Prior to the placement of slabs-on-grade on this site, the recommendations for subgrade preparation in the Site Preparation and Earthwork and Controlled Compacted Fill Sections of this report should be implemented.

It is recommended that slabs-on-grade be placed on a capillary barrier consisting of clean, granular material. The capillary barrier should be at least 6 inches in thickness and consist of uniformly graded sand or gravel. The use of a plastic vapor barrier is left to the discretion of the architect. If a vapor barrier is used and the materials beneath the plastic sheet contain sharp, irregular particles, care should be taken to protect the vapor barrier from puncture. When a vapor barrier is used, proper curing conditions must be maintained to reduce the potential for differential curing and

possible curling of the floor slab.

Slabs-on-grade should be suitably reinforced and proper joints should be provided at the junctions of the slab and foundation system so that a small amount of independent movement can occur without causing damage.

CONSTRUCTION CONSIDERATIONS

Groundwater Control

It is recommended that appropriate dewatering equipment be available to control any groundwater which may be encountered during excavation, and the construction should be completed under relatively dry conditions. When designing site drainage patterns, site runoff should be diverted away from the foundations and directed towards on-site detention areas, or storm sewer systems. Such measures reduce the potential for softening and possible erosion of the foundation and pavement subgrade soils. It is especially important that water not be allowed to collect next to the building foundations.

Excavations

All excavations should comply with the requirements of OSHA 29CFR, Part 1926, Subpart P, "Excavations," regarding excavation and trench safety, as well as other applicable codes. This document states that excavation safety is the sole responsibility of the contractor and accordingly reference to this OSHA requirement should be included in the project specifications. Excavation slopes shall in no case be steeper than those specified by OSHA, and all excavations should be monitored by a competent person, as defined by the OSHA standard. Appropriate shoring or sloping techniques should be used to prevent cave-ins.

Excavations near existing foundations should be made with caution as disturbance within foundation influence zones that support adjacent structures could result in excessive settlement. If the proposed construction will extend into the influence zone of the existing foundations, a shoring or underpinning system may be required to protect or support the adjacent structures.

GENERAL COMMENTS

This geotechnical exploration and foundation analysis has been conducted to aid in the evaluation of the foundation conditions on the subject site. The recommendations presented herein are based on the available soil information obtained and the design information provided. Any changes in the soil conditions encountered during construction, design, or building locations should be brought to the attention of the soils engineer to determine if modifications in the recommendations are required. The final design plans and specifications should also be reviewed by the soils engineer to determine that the recommendations presented herein have been interpreted and implemented as intended. It is recommended that the earthwork and foundation operations be monitored by the Geotechnical Engineer, to test and evaluate the bearing capacities, and the selection, placement and compaction of controlled fills.

This geotechnical study has been conducted in a manner consistent with that level of care ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. The findings, recommendations, and opinions contained herein have been promulgated in accordance with generally accepted practice in the fields of foundation engineering, soils

mechanics, and engineering geology. No other representations, expressed or implied, and no warranty or guarantee is included or intended in this report.

APPENDIX

Figure 1 – Site Vicinity Map
Figure 2 – Boring Location Diagram
Boring Logs
General Notes

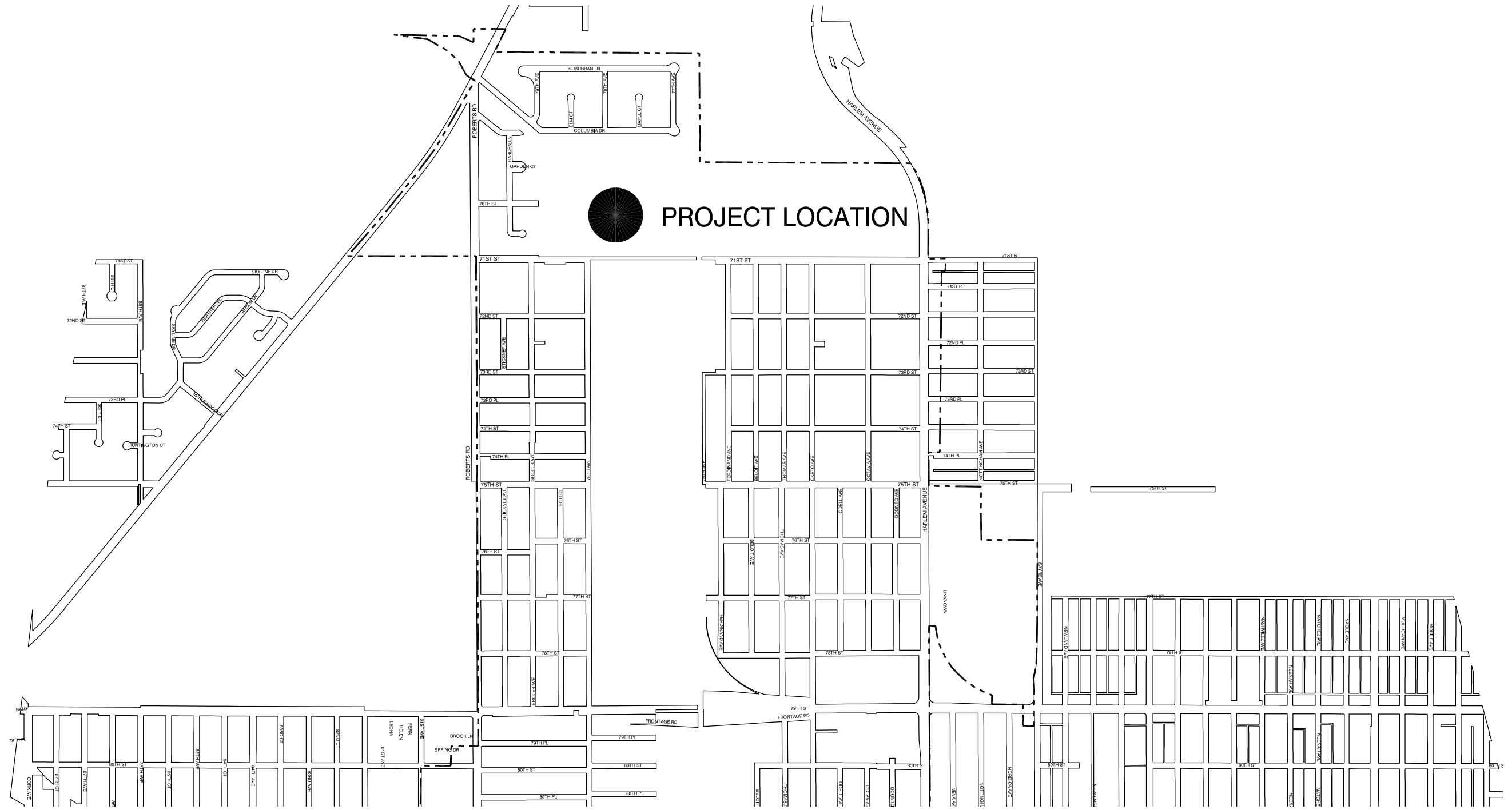


	FIGURE LOCATION MAP TOYOTA PARK 7300 WEST 71ST STREET BRIDGEVIEW	PROJECT NO: 11-G660
		DATE: 01-16-12
		11-G660-FIG-1

CLIENT Robinson Engineering, LTD. PROJECT NAME PACE Bus Station
 PROJECT NUMBER 11-G660 PROJECT LOCATION Toyota Park, Bridgeview, IL
 DATE COMPLETED 1/11/12 LOGGED BY NJ/DS DRILLING METHOD 3.25 in. I.D. HSA

DEPTH (ft)	ELEVATION (ft.)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (Qp) (tsf)	UNC. STRENGTH (Qu) (tsf)	MOISTURE CONTENT (%)	DRY UNIT WT. (pcf)	ORGANIC CONTENT (%)	ATTERBERG LIMITS				
												LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
0																
	613.3		0 to 8 inches asphalt pavement													
	612.5		8 to 18 inches aggregate base material													
			Brown and grey mottled silty clay, trace sand and fine gravel, slightly moist, hard	SS 1	22	10-10-8 (18)			6.0							
5				SS 2	56	6-12-12 (24)	4.5+	5.1	20.0							
				SS 3	78	4-8-13 (21)	4.5+	6.1	18.9							
10	605.0		Grey silty clay, trace sand and fine gravel, slightly moist, hard	SS 4	89	3-6-9 (15)	3.5	4.3	18.5							
15				SS 5	56	3-7-10 (17)	4.5	5.1	18.3							
20				SS 6	67	3-7-11 (18)	4.5	5.9	17.9							
25				SS 7	78	5-9-12 (21)	4.5+	8.0	13.6							
30	584.0			SS 8	67	7-13-17 (30)	4.5+	10.4	13.9							
Bottom of borehole at 30.0 feet.																

COMPLETION DEPTH 30 ft GROUND ELEVATION 614 ft MSL
 CAVE DEPTH 16 ft BACKFILL Soil Cuttings
 GROUND WATER LEVELS:
 AT TIME OF DRILLING --- None
 AT END OF DRILLING --- Dry at Cave Depth
 AFTER DRILLING ---

NOTES

Lines of Demarcation represent an **approximate** boundary between soil types. Variations may occur between sampling intervals and between boring locations, and the transition may be gradual. Dashed lines are indicative of potentially erratic or unknown changes.

GPS STANDARD GEOTECH LOG - GPS STD DATA TEMPLATE.GDT - 1/17/12 11:31 - C:\GINT\PROJECTS\11-G660 PACE BUS STATION, BRIDGEVIEW, IL.GPJ

CLIENT Robinson Engineering, LTD. PROJECT NAME PACE Bus Station
 PROJECT NUMBER 11-G660 PROJECT LOCATION Toyota Park, Bridgeview, IL
 DATE COMPLETED 1/11/12 LOGGED BY NJ/DS DRILLING METHOD 3.25 in. I.D. HSA

DEPTH (ft)	ELEVATION (ft.)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (qp) (tsf)	UNC. STRENGTH (Qu) (tsf)	MOISTURE CONTENT (%)	DRY UNIT WT. (pcf)	ORGANIC CONTENT (%)	ATTERBERG LIMITS			
												LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0															
	613.5		0 to 6 inches asphalt pavement												
	612.8		6 to 14 inches aggregate base material												
			Brown and grey mottled silty clay, trace sand and fine gravel, slightly moist, hard	SS 1	78	5-7-11 (18)	4.0	4.6	20.7						
5				SS 2	89	6-12-12 (24)	4.5+	6.2	20.0						
				SS 3	89	5-10-13 (23)	4.5+	6.6	20.0						
10	605.0		Grey silty clay, trace sand and fine gravel, slightly moist, very stiff to hard	SS 4	78	4-7-7 (14)	3.5	4.5	18.2						
15				SS 5	78	2-5-6 (11)	2.5	3.4	18.9						
20				SS 6	78	5-13-14 (27)	4.5+	5.8	13.8						
25				SS 7	67	6-14-18 (32)	4.5+	6.2	13.6						
30	584.0			SS 8	67	7-13-16 (29)	4.5+	10.4	13.1						

Bottom of borehole at 30.0 feet.

COMPLETION DEPTH 30 ft GROUND ELEVATION 614 ft MSL
 CAVE DEPTH 18 ft BACKFILL Soil Cuttings
 GROUND WATER LEVELS:
 AT TIME OF DRILLING --- None
 AT END OF DRILLING --- Dry at Caved Depth
 AFTER DRILLING ---

NOTES

Lines of Demarcation represent an **approximate** boundary between soil types. Variations may occur between sampling intervals and between boring locations, and the transition may be gradual. Dashed lines are indicative of potentially erratic or unknown changes.

CLIENT Robinson Engineering, LTD.

PROJECT NAME PACE Bus Station
















PROJECT NUMBER 11-G660

PROJECT LOCATION Toyota Park, Bridgeview, IL




SAMPLE IDENTIFICATION

Visual soil classifications are made in general accordance with the United Soil Classification System (USCS) on the basis of textural and particle size categorization, and various soil behavior characteristics. Visual classifications should be substantiated by appropriate laboratory testing when a more exact soil identification is required to satisfy specific project applications criteria.


UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487-98)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND	
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	$C_u \geq 4$ AND $1 \leq C_c \leq 3$	GW	WELL-GRADED GRAVEL	
			$C_u \geq 4$ AND/OR $1 \geq C_c \geq 3$	GP	POORLY-GRADED GRAVEL	
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR CL	GM	SILTY GRAVEL	
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL	
	SANDS >50% OF COARSE FRACTION PASSES ON NO 4. SIEVE	CLEAN SANDS <5% FINES	$C_u \geq 6$ AND $1 \leq C_c \leq 3$	SW	WELL-GRADED SAND	
			$C_u \geq 6$ AND/OR $1 \geq C_c \geq 3$	SP	POORLY-GRADED SAND	
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND	
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND	
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT <50	INORGANIC	PI >7 AND PLOTS >"A" LINE	CL	LEAN CLAY	
			PI >4 AND PLOTS <"A" LINE	ML	SILT	
		ORGANIC	LL (oven dried)/LL (not dried) <0.75	OL	ORGANIC CLAY OR SILT	
	SILTS AND CLAYS LIQUID LIMIT >50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY	
			PI PLOTS <"A" LINE	MH	ELASTIC SILT	
		ORGANIC	LL (oven dried)/LL (not dried) <0.75	OH	ORGANIC CLAY OR SILT	
HIGHLY ORGANIC SOILS	PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR			PT	PEAT	

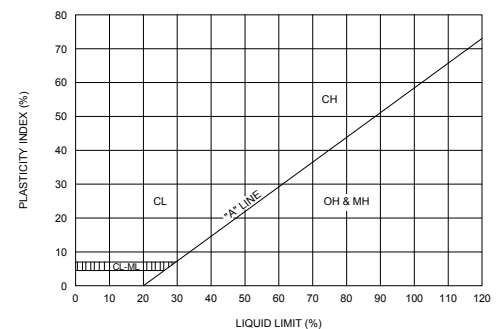
PROJECT LITHOLOGIC SYMBOLS (USCS)

 ASPHALT: Asphalt	 CL: USCS Low Plasticity Clay	 GRAVEL FILL
--	--	---

PROJECT SAMPLE TYPES

 Split Spoon (SS)

PLASTICITY CHART



SOIL RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

NON-COHESIVE SOILS		COHESIVE SOILS		
RELATIVE DENSITY	N-VALUE*	CONSISTENCY	N-VALUE*	COMPRESSIVE STRENGTH (TSF)
VERY LOOSE	0 - 3	VERY SOFT	0 - 2	0 - 0.25
LOOSE	3 - 7	SOFT	2 - 5	0.25 - 0.50
MEDIUM DENSE	7 - 15	MEDIUM STIFF	5 - 10	0.50 - 1.0
DENSE	15 - 38	STIFF	10 - 14	1.0 - 2.0
VERY DENSE	OVER 38	VERY STIFF	14 - 32	2.0 - 4.0
		HARD	OVER 32	OVER 4.0

ABBREVIATIONS

SS - SPLIT-SPOON SAMPLE	LL - LIQUID LIMIT (%)
ST - SHELBY TUBE SAMPLE	PL - PLASTIC LIMIT (%)
AU - AUGER SAMPLE	PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)	NP - NON PLASTIC
-200 - PERCENT PASSING NO. 200 SIEVE	DD - DRY DENSITY (PCF)
Qp - POCKET PENETROMETER (TSF)	DCP - DYNAMIC CONE PENETROMETER
Qu - UNCONFINED STRENGTH (TSF)	IBV - IMMEDIATE BEARING VALUE

* N-VALUE: NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

INTENTIONALLY LEFT BLANK

Any and all references within these IDOT REQUIRED SPECIAL PROVISIONS FOR ROADWAY LIGHTING pertaining to payment for an item be means of a contract unit price shall be considered void.

Any specifications outlined in the section below titled "IDOT REQUIRED SPECIAL PROVISIONS FOR ROADWAY LIGHT" shall be meant to apply to the work to supply the power feed from the Commonwealth Edison transformer to the buildings electrical panel. No section of this specification shall be interpreted as applying to any electrical work within the transit center building.

IDOT REQUIRED SPECIAL PROVISIONS FOR ROADWAY LIGHTING

The contractor shall comply to the latest IDOT "Standard Specifications for Road and Bridge Construction" for Roadway Lighting work except as amended as follows:

General Electrical Requirements

Effective: January 1, 2012

Revised by Robinson Engineering to remove GPS location requirements for this project.

Add the following to Article 801 of the Standard Specifications:

"Maintenance transfer and Preconstruction Inspection:

General. Before performing any excavation, removal, or installation work (electrical or otherwise) at the site, the Contractor shall request a maintenance transfer and preconstruction site inspection, to be held in the presence of the Engineer and a representative of the party or parties responsible for maintenance of any lighting and/or traffic control systems which may be affected by the work. The request for the maintenance transfer and preconstruction inspection shall be made no less than seven (7) calendar days prior to the desired inspection date. The maintenance transfer and preconstruction inspection shall:

Establish the procedures for formal transfer of maintenance responsibility required for the construction period.

Establish the approximate location and operating condition of lighting and/or traffic control systems which may be affected by the work

Marking of Existing Cable Systems. The party responsible for maintenance of any existing lighting and/or traffic control systems at the project site will, at the Contractor's request, mark and/or stake, once per location, all underground cable routes owned or maintained by the State. A project may involve multiple "locations" where separated electrical systems are involved (i.e. different controllers). The markings shall be taken to have a horizontal tolerance of at least 304.8 mm (one (1) foot) to either side.. The request for the cable locations and marking shall be made at the same time the request for the maintenance transfer and preconstruction inspection is made. The Contractor shall exercise extreme

caution where existing buried cable runs are involved. The markings of existing systems are made strictly for assistance to the Contractor and this does not relieve the Contractor of responsibility for the repair or replacement of any cable run damaged in the course of his work, as specified elsewhere herein. Note that the contractor shall be entitled to only one request for location marking of existing systems and that multiple requests may only be honored at the contractor's expense. No locates will be made after maintenance is transferred, unless it is at the contractor's expense.

Condition of Existing Systems. The Contractor shall conduct an inventory of all existing electrical system equipment within the project limits, which may be affected by the work, making note of any parts which are found broken or missing, defective or malfunctioning. Megger and load readings shall be taken for all existing circuits which will remain in place or be modified. If a circuit is to be taken out in its entirety, then readings do not have to be taken. The inventory and test data shall be reviewed with and approved by the Engineer and a record of the inventory shall be submitted to the Engineer for the record. Without such a record, all systems transferred to the Contractor for maintenance during construction shall be returned at the end of construction in complete, fully operating condition.”

Add the following to the 1st paragraph of Article 801.05(a) of the Standard Specifications:

“Items from multiple disciplines shall not be combined on a single submittal and transmittal. Items for lighting, signals, surveillance and CCTV must be in separate submittals since they may be reviewed by various personnel in various locations.”

Revise the second sentence of the 5th paragraph of Article 801.05(a) of the Standard Specifications to read:

“The Engineer will stamp the submittals indicating their status as ‘Approved’, ‘Approved as Noted’, ‘Disapproved’, or ‘Information Only’.

Revise the 6th paragraph of Article 801.05(a) of the Standard Specifications to read:

Resubmittals. All submitted items reviewed and marked ‘Approved as Noted’, or ‘Disapproved’ are to be resubmitted in their entirety with a disposition of previous comments to verify contract compliance at no additional cost to the state unless otherwise indicated within the submittal comments.”

Revise Article 801.11(a) of the Standard Specifications to read:

Lighting Operation and Maintenance Responsibility. The scope of work shall include the assumption of responsibility for the continuing operation and maintenance the of existing, proposed, temporary, sign and navigation lighting, or other lighting systems and all appurtenances affected by the work as specified elsewhere herein. Maintenance of lighting systems is specified elsewhere and will be paid for separately

Energy and Demand Charges. The payment of basic energy and demand charges by the electric utility for existing lighting which remains in service will continue as a responsibility of the Owner, unless otherwise indicated. Unless otherwise indicated or required by the Engineer duplicate lighting systems (such as temporary lighting and proposed new lighting) shall not be operated simultaneously at the Owner's expense and lighting systems shall not be kept in operation during long daytime periods at the Owner's expense. Upon written authorization from the Engineer to place a proposed new lighting system in service, whether the system has passed final acceptance or not, (such as to allow temporary lighting to be removed), the Owner will accept responsibility for energy and demand charges for such lighting, effective the date of authorization. All other energy and demand payments to the utility shall be the responsibility of the Contractor until final acceptance.”

Add the following to Section 801 of the Standard Specifications:

“Lighting Cable Identification. Each wire installed shall be identified with its complete circuit number at each termination, splice, junction box or other location where the wire is accessible.”

“Lighting Cable Fuse Installation. Standard fuse holders shall be used on non-frangible (non-breakaway) light pole installations and quick-disconnect fuse holders shall be used on frangible (breakaway) light pole installations. Wires shall be carefully stripped only as far as needed for connection to the device. Over-stripping shall be avoided. An oxide inhibiting lubricant shall be applied to the wire for minimum connection resistance before the terminals are crimped-on. Crimping shall be performed in accordance with the fuse holder manufacturer's recommendations. The exposed metal connecting portion of the assembly shall be taped with two half-lapped wraps of electrical tape and then covered by the specified insulating boot. The fuse holder shall be installed such that the fuse side is connected to the pole wire (load side) and the receptacle side of the holder is connected to the line side.”

Revise the 2nd paragraph of Article 801.16 of the Standard Specifications to read:

“When the work is complete, and seven days before the request for a final inspection, the full-size set of contract drawings. Stamped “RECORD DRAWINGS”, shall be submitted to the Engineer for review and approval and shall be stamped with the date and the signature of the Contractor’s supervising Engineer or electrician. The record drawings shall be submitted in PDF format on CDROM as well as hardcopy for review and approval. In addition to the record drawings, copies of the final catalog cuts which have been Approved or Approved as Noted shall be submitted in PDF format along with the record drawings. The PDF files shall clearly indicate either by filename or PDF table of contents the respective pay item number. Specific part or model numbers of items which have been selected shall be clearly visible.”

Underground Raceways
Effective: January 1, 2012

Revise Article 810.04 of the Standard Specifications to read:

“Installation. All underground conduit shall have a minimum depth of 30-inches (700 mm) below the finished grade.”

Add the following to Article 810.04 of the Standard Specifications:

“All metal conduit installed underground shall be Rigid Steel Conduit unless otherwise indicated on the plans.”

Add the following to Article 810.04 of the Standard Specifications:

“All raceways which extend outside of a structure or duct bank but are not terminated in a cabinet, junction box, pull box, handhole, post, pole, or pedestal shall extend a minimum of 300 mm (12”) or the length shown on the plans beyond the structure or duct bank. The end of this extension shall be capped and sealed with a cap designed for the conduit to be capped. The ends of rigid metal conduit to be capped shall be threaded, the threads protected with full galvanizing, and capped with a threaded galvanized steel cap. The ends of rigid nonmetallic conduit and coilable nonmetallic conduit shall be capped with a rigid PVC cap of not less than 3 mm (0.125”) thick. The cap shall be sealed to the conduit using a room-temperature-vulcanizing (RTV) sealant compatible with the material of both the cap and the conduit. A washer or similar metal ring shall be glued to the inside center of the cap with epoxy, and the pull cord shall be tied to this ring.”

Add the following to Article 810.04(c) of the Standard Specifications:

“Coilable non-metallic conduit shall be machine straightened to remove the longitudinal curvature caused by coiling the conduit onto reels prior to installing in trench, encasing in concrete or embedding in structure. The straightening shall not deform the cross-section of the conduit such that any two measured outside diameters, each from any location and at any orientation around the longitudinal axis along the conduit differ by more than 6 mm (0.25”).” The longitudinal axis of the straightened conduit shall not deviate by more than 20 mm per meter (0.25” per foot” from a straight line. The HDPE and straightening mechanism manufacturer operating temperatures shall be followed.

Exposed Raceways

Effective: January 1, 2012

Revise the first paragraph of Article 811.03(a) of the Standard Specifications to read:

“General. Rigid metal conduit installation shall be according to Article 810.05(a). Conduits terminating in junction and pull boxes shall be terminated with insulated and

gasketed watertight threaded NEMA 4X conduit hubs. The hubs shall be Listed under UL 514B. The insulated throat shall be rated up to 105° C. When PVC coated conduit is utilized, the aforementioned hubs shall also be PVC coated.”

Add the following to Article 811.03(b) of the Standard Specifications:

“Where PVC coated conduit is utilized, all conduit fittings, couplings and clamps shall be PVC coated. All other mounting hardware and appurtenances shall be stainless steel.”

“The personnel installing the PVC coated conduit must be trained and certified by the PVC coated conduit Manufacturer or Manufacturer’s representative to install PVC coated conduit. Documentation demonstrating this requirement must be submitted for review and approval.”

Add the following to Article 1088.01(a) of the Standard Specifications:

All iron and steel products, which are to be incorporated into the work, including conduit and all conduit fittings, shall be domestically manufactured or produced and fabricated as specified in Article 106.”

Revise Article 1088.01(a)(3) of the Standard Specifications to read:

“a. PVC Coated Steel Conduit. The PVC coated rigid metal conduit shall be UL Listed (UL 6). The PVC coating must have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations shall be UL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating shall be UL listed.

b. The PVC coating shall have the following characteristics:

Hardness:	85+ Shore A Durometer
Dielectric Strength:	400V/mil @ 60 Hz
Aging:	1,000 Hours Atlas Weatherometer
Temperature	The PVC compound shall conform at 0° F. to Federal Specifications PL-406b, Method 2051, Amendment 1 of 25 September 1952 (ASTM D 746)
Elongation:	200%

c. The exterior and interior galvanized conduit surface shall be chemically treated to enhance PVC coating adhesion and shall also be coated with a primer before the PVC coating to ensure a bond between the zinc substrate and the PVC coating. The bond strength created shall be greater than the tensile strength of the plastic coating.

- d. The nominal thickness of the PVC coating shall be 1 mm (40 mils). The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above -1°C (30°F).
- e. An interior urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. The interior coating shall be applied in a manner so there are no runs, drips, or pinholes at any point. The coating shall not peel, flake, or chip off after a cut is made in the conduit or a scratch is made in the coating.
- f. Conduit bodies shall have a tongue-in-groove gasket for maximum sealing capability. The design shall incorporate a positive placement feature to assure proper installation. Certified test results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours shall be submitted for review when requested by the Engineer.
- g. The PVC conduit shall pass the following tests:

Exterior PVC Bond test RN1:

Two parallel cuts 13 mm (1/2 inch) apart and 40 mm (1 1/2 inches) in length shall be made with a sharp knife along the longitudinal axis. A third cut shall be made perpendicular to and crossing the longitudinal cuts at one end. The knife shall then be worked under the PVC coating for 13 mm (1/2 inch) to free the coating from the metal.

Using pliers, the freed PVC tab shall be pulled with a force applied vertically and away from the conduit. The PVC tab shall tear rather than cause any additional PVC coating to separate from the substrate.

Boil Test:

Acceptable conduit coating bonds (exterior and interior) shall be confirmed if there is no disbondment after a minimum average of 200 hours in boiling water or exposure to steam vapor at one atmosphere. Certified test results from a national recognized independent testing laboratory shall be submitted for review and approval. The RN1 Bond Test and the Standard Method for Measuring Adhesion by Tape Test shall be utilized.

Exterior Adhesion. In accordance with ASTM D870, a 6" length of conduit test specimen shall be placed in boiling water. The specimen shall be periodically removed, cooled to ambient temperature and immediately tested according to the bond test (RN1). When the PVC coating separates from the substrate, the boil time to failure in hours shall be recorded.

Interior Adhesion. In accordance with ASTM D3359, a 6" conduit test specimen shall be cut in half longitudinally and placed in boiling water or

directly above boiling water with the urethane surface facing down. The specimen shall be periodically removed, cooled to ambient temperature and tested in accordance with the Standard Method of Adhesion by Tape Test (ASTM D3359). When the coating disbonds, the time to failure in hours shall be recorded.

Heat/Humidity Test:

Acceptable conduit coating bonds shall be confirmed by a minimum average of 30 days in the Heat and Humidity Test. The RN1 Bond Test and the Standard Method for Measuring Adhesion by Tape Test shall be utilized.

Exterior Adhesion. In accordance with ASTM D1151, D1735, D2247 and D4585, conduit specimens shall be placed in a heat and humidity environment where the temperature is maintained at 150°F (66°C) and 95% relative humidity. The specimens shall be periodically removed and a bond test (RN1) performed. When the PVC coating separates from the substrate, the exposure time to failure in days shall be recorded.

Interior Adhesion. In accordance with ASTM D3359, conduit specimens shall be placed in a heat and humidity environment where the temperature is maintained at 150°F (66°C) and 95% relative humidity. When the coating disbonds, the time to failure in hours shall be recorded.

Add the following to Article 1088.01(a)(4) of the Standard Specifications:

“All liquid tight flexible metal conduit fittings shall have an insulated throat to prevent abrasion of the conductors and shall have a captive sealing O-ring gasket. The fittings shall be Listed under UL 514B. The insulated throat shall be rated up to 105° C.”

Revise the second paragraph of Article 811.04 of the Standard Specifications to read:

“Expansion fittings and LFNC will not be measured for payment.”

Revise Article 811.05 of the Standard Specifications to read:

“811.05 Basis of Payment. This work will be paid for at the contract unit price per meter (foot) for CONDUIT ATTACHED TO STRUCTURE, of the diameter specified, RIGID GALVANIZED STEEL or CONDUIT ATTACHED TO STRUCTURE, of the diameter specified, RIGID GALVANIZED STEEL, PVC COATED.”

Unit Duct

Effective: January 1, 2012

Revise the first paragraph of Article 810.04 to read:

“The unit duct shall be installed at a minimum depth of 30-inches (760 mm) unless otherwise directed by the Engineer.”

Revise Article 1088.01(c) to read:

“(c) Coilable Nonmetallic Conduit.

General:

The duct shall be a plastic duct which is intended for underground use and which can be manufactured and coiled or reeled in continuous transportable lengths and uncoiled for further processing and/or installation without adversely affecting its properties of performance. The duct shall be a plastic duct which is intended for underground use and can be manufactured and coiled or reeled in continuous transportable lengths and uncoiled for further processing and/or installation without adversely affecting its properties of performance.

The duct shall be made of high density polyethylene which shall meet the requirements of ASTM D 2447, for schedule 40. The duct shall be composed of black high density polyethylene meeting the requirements of ASTM D 3350, Class C, Grade P33. The wall thickness shall be in accordance with Table 2 for ASTM D 2447.

The duct shall be UL Listed per 651-B for continuous length HDPE coiled conduit. The duct shall also comply with NEC Article 354.100 and 354.120.

Submittal information shall demonstrate compliance with the details of these requirements.

Dimensions:

Duct dimensions shall conform to the standards listed in ASTM D2447. Submittal information shall demonstrate compliance with these requirements.

Nominal Size		Nominal I.D.		Nominal O.D.		Minimum Wall	
mm	in	mm	in	mm	in	mm	in
31.75	1.25	35.05	1.380	42.16	1.660	3.556 +0.51	0.140 +0.020
38.1	1.50	40.89	1.610	48.26	1.900	3.683 +0.51	0.145 +0.020

Nominal Size		Pulled Tensile	
mm	in	N	lbs
31.75	1.25	3322	747
38.1	1.50	3972	893

Marking:

As specified in NEMA Standard Publication No. TC-7, the duct shall be clearly and durably marked at least every 3.05 meters (10 feet) with the material designation (HDPE for high density polyethylene), nominal size of the duct and the name and/or trademark of the manufacturer.

Performance Tests:

Polyethylene Duct testing procedures and test results shall meet the requirements of UL 651. Certified copies of the test report shall be submitted to the Engineer prior to the installation of the duct. Duct crush test results shall meet or exceed the following requirements:

Duct Diameter		Min. force required to deform sample 50%	
mm	in	N	lbs
35	1.25	4937	1110
41	1.5	4559	1025

Wire and Cable

Effective: January 1, 2012

Add the following to the first paragraph of Article 1066.02(a):

“The cable shall be rated at a minimum of 90°C dry and 75°C wet and shall be suitable for installation in wet and dry locations, and shall be resistant to oils and chemicals.”

Revise the Aerial Electric Cable Properties table of Article 1066.03(a)(3) to read:

Aerial Electric Cable Properties

Phase Conductor		Messenger wire			
Size AWG	Stranding	Average Insulation Thickness		Minimum Size AWG	Stranding
		mm	mils		
6	7	1.1	(45)	6	6/1
4	7	1.1	(45)	4	6/1
2	7	1.1	(45)	2	6/1
1/0	19	1.5	(60)	1/0	6/1
2/0	19	1.5	(60)	2/0	6/1
3/0	19	1.5	(60)	3/0	6/1
4/0	19	1.5	(60)	4/0	6/1

Add the following to Article 1066.03(b) of the Standard Specifications:

“Cable sized No. 2 AWG and smaller shall be U.L. listed Type RHH/RHW and may be Type RHH/RHW/USE. Cable sized larger than No. 2 AWG shall be U.L. listed Type RHH/RHW/USE.”

Revise Article 1066.04 to read:

“Aerial Cable Assembly. The aerial cable shall be an assembly of insulated aluminum conductors according to Section 1066.02 and 1066.03. Unless otherwise indicated, the cable assembly shall be composed of three insulated conductors and a steel reinforced bare aluminum conductor (ACSR) to be used as the ground conductor. Unless otherwise indicated, the code word designation of this cable assembly is “Palomino”. The steel reinforced aluminum conductor shall conform to ASTM B-232. The cable shall be assembled according to ANSI/ICEA S-76-474.”

Revise the second paragraph of Article 1066.05 to read:

“The tape shall have reinforced metallic detection capabilities consisting of a woven reinforced polyethylene tape with a metallic core or backing.”

Luminaire

Effective: January 1, 2012

Revised by Robinson Engineering to remove independent testing requirements for local projects.

Add the following to first paragraph of Article 1067(c) of the Standard Specifications:

“The reflector shall not be altered by paint or other opaque coatings which would cover or coat the reflecting surface. Control of the light distribution by any method other than the reflecting material and the aforementioned clear protective coating that will alter the reflective properties of the reflecting surface is unacceptable”

Add the following to Article 1067(f) of the Standard Specifications:

“The ballast shall be a High Pressure Sodium, high power factor, constant wattage auto-regulator, lead type (CWA) for operation on a nominal 240 volt system.”

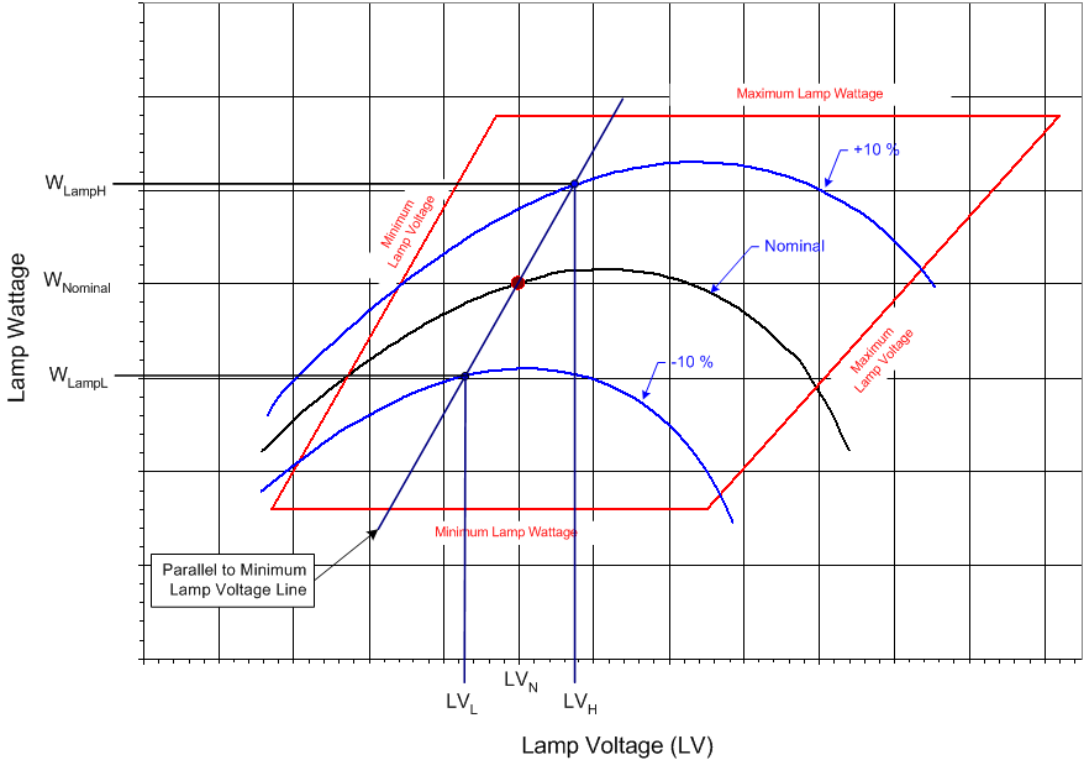
Revise Article 1067(f)(1) of the Standard Specifications to read:

“The high pressure sodium, auto-regulator, lead type (CWA) ballast shall be designed to ANSI Standards and shall be designed and rated for operation on a nominal 240 volt system. The ballast shall provide positive lamp ignition at the input voltage of 216 volts. It shall operate the lamp over a range of input voltages from 216 to 264 volts without damage

to the ballast. It shall provide lamp operation within lamp specifications for rated lamp life at input design voltage range. Operating characteristics shall produce output regulation not exceeding the following values:

Nominal Ballast Wattage	Maximum Ballast Regulation
750	25%
400	26%
310	26%
250	26%
150	24%
70	18%

For this measure, regulation shall be defined as the ratio of the lamp watt difference between the upper and lower operating curves to the nominal lamp watts; with the lamp watt difference taken within the ANSI trapezoid at the nominal lamp operating voltage point parallel to the minimum lamp volt line:



$$\text{Ballast Regulation} = \frac{W_{LampH} - W_{LampL}}{W_{LampN}} \times 100$$

where:

W_{LampH} = lamp watts at +10% line voltage when Lamp voltage = LV_H

W_{LampL} = lamp watts at - 10% line voltage when lamp voltage = LV_L

W_{lampN} = lamp watts at nominal lamp operating voltage = LV_N

Wattage	Nominal Lamp Voltage, LV_N	LV_L	LV_H
750	120v	115v	125v
400	100v	95v	105v
310	100v	95v	105v
250	100v	95v	105v
150	55v	50v	60v
70	52v	47v	57v

Ballast losses, based on cold bench tests, shall not exceed the following values:

Nominal Ballast Wattage	Maximum Ballast Losses
750	15%
400	20%
310	21%
250	24%
150	26%
70	34%

Ballast losses shall be calculated based on input watts and lamp watts at nominal system voltage as indicated in the following equation:

$$\text{Ballast Losses} = \frac{W_{Line} - W_{Lamp}}{W_{Lamp}} \times 100$$

where:

W_{line} = line watts at nominal system voltage

$$W_{lamp} = \text{lamp watts at nominal system voltage}$$

Ballast output to lamp. At nominal system voltage and nominal lamp voltage, the ballast shall deliver lamp wattage with the variation specified in the following table.

Nominal Ballast Wattage	Output to lamp variation
750	± 7.5%
400	± 7.5%
310	± 7.5%
250	± 7.5%
150	± 7.5%
70	± 7.5%

Example: For a 400w luminaire, the ballast shall deliver 400 watts ±7.5% at a lamp voltage of 100v for the nominal system voltage of 240v which is the range of 370w to 430w.

Ballast output over lamp life. Over the life of the lamp the ballast shall produce average output wattage of the nominal lamp rating as specified in the following table. Lamp wattage readings shall be taken at 5-volt increments throughout the ballast trapezoid. Reading shall begin at the lamp voltage (L_v) specified in the table and continue at 5 volt increments until the right side of the trapezoid is reached. The lamp wattage values shall then be averaged and shall be within the specified value of the nominal ballast rating. Submittal documents shall include a tabulation of the lamp wattage vs. lamp voltage readings.

Nominal Ballast Wattage	LV Readings begin at	Maximum Wattage Variation
750	110v	± 7.5%
400	90v	± 7.5%
310	90v	± 7.5%
250	90v	± 7.5%
150	50v	± 7.5%
70	45v	± 7.5%

Example: For a 400w luminaire, the averaged lamp wattage reading shall not exceed the range of ±7.5% which is 370w to 430w"

Revise Article 1067.06(a)(1) of the Standard Specifications to read:

“The lamps shall be of the clear type and shall have a color of 1900° to 2200° Kelvin.”

Maintenance of Lighting Systems

Effective: January 1, 2012

Revised by Robinson Engineering to include temporary lighting as incidental to this pay item.

Replace Article 801.11 and 801.12 of the Standard Specifications with the following:

Effective the date the Contractor's activities (electrical or otherwise) at the job site begin, the Contractor shall be responsible for the proper operation and maintenance of all existing and proposed lighting systems which are part of, or which may be affected by the work until final acceptance or as otherwise determined by the Engineer.

Before performing any excavation, removal, or installation work (electrical or otherwise) at the site, the Contractor shall initiate a request for a maintenance transfer and preconstruction inspection, as specified elsewhere herein, to be held in the presence of the Engineer and a representative of the party or parties responsible for maintenance of any lighting systems which may be affected by the work. The request for the maintenance preconstruction inspection shall be made no less than seven (7) calendar days prior to the desired inspection date.

Existing lighting systems, when depicted on the plans, are intended only to indicate the general equipment installation of the systems involved and shall not be construed as an exact representation of the field conditions. It remains the Contractor's responsibility to visit the site to confirm and ascertain the exact condition of the electrical equipment and systems to be maintained.

Maintenance of Existing Lighting Systems

Existing lighting systems. Existing lighting systems shall be defined as any lighting system or part of a lighting system in service at the time of contract Letting. The contract drawings indicate the general extent of any existing lighting, but whether indicated or not, it remains the Contractor's responsibility to ascertain the extent of effort required for compliance with these specifications and failure to do so will not be justification for extra payment or reduced responsibilities.

Extent of Maintenance.

Partial Maintenance. Unless otherwise indicated, if the number of circuits affected by the contract is equal to or less than 40% of the total number of circuits in a given controller and the controller is not part of the contract work, the Contractor needs only to maintain the affected circuits. The affected circuits shall be isolated by means of in-line waterproof fuse holders as specified elsewhere and as approved by the Engineer.

Full Maintenance. If the number of circuits affected by the contract is greater than 40% of the total number of circuits in a given controller, or if the controller is modified in any way

under the contract work, the Contractor shall maintain the entire controller and all associated circuits.

Maintenance of Proposed Lighting Systems

Proposed Lighting Systems. Proposed lighting systems shall be defined as any lighting system or part of a lighting system, temporary or permanent, which is to be constructed under this contract.

The Contractor shall be fully responsible for maintenance of all items installed under this contract. Maintenance shall include, but not be limited to, any equipment failures or malfunctions as well as equipment damage either by the motoring public, Contractor operations, vandalism, or other means. The potential cost of replacing or repairing any malfunctioning, damaged, or vandalized equipment shall be included in the bid price of this item and will not be paid for separately.

Lighting System Maintenance Operations

The Contractor's responsibility shall include all applicable responsibilities of the Electrical Maintenance Contract, State of Illinois, Department of Transportation, Division of Highways, District One. These responsibilities shall include the maintenance of lighting units (including sign lighting), cable runs and lighting controls. In the case of a pole knockdown or sign light damage, the Contractor shall promptly clear the lighting unit and circuit discontinuity and restore the system to service. The equipment shall then be re-set by the contractor within the time limits specified herein.

If the equipment damaged by normal vehicular traffic, not contractor operations, is beyond repair and cannot be re-set, the contractor shall replace the equipment in kind with payment made for such equipment under Article 109.04. If the equipment damaged by any construction operations, not normal vehicular traffic, is beyond repair and cannot be re-set, the contractor shall replace the equipment in kind and the cost of the equipment shall be included in the cost of this pay item and shall not be paid for separately.

Responsibilities shall also include weekly night-time patrol of the lighting system, with patrol reports filed immediately with the Engineer and with deficiencies corrected within 24 hours of the patrol. Patrol reports shall be presented on standard forms as designated by the Engineer. Uncorrected deficiencies may be designated by the Engineer as necessitating emergency repairs as described elsewhere herein.

The following chart lists the maximum response, service restoration, and permanent repair time the Contractor will be allowed to perform corrective action on specific lighting system equipment.

INCIDENT OR PROBLEM	SERVICE RESPONSE TIME	SERVICE RESTORATION TIME	PERMANENT REPAIR TIME
Control cabinet out	1 hour	4 hours	7 Calendar days
Hanging mast arm	1 hour to	na	7 Calendar

	clear		days
Radio problem	1 hour	4 hours	7 Calendar days
Motorist caused damage or leaning light pole 10 degrees or more	1 hour to clear	4 hours	7 Calendar days
Circuit out – Needs to reset breaker	1 hour	4 hours	na
Circuit out – Cable trouble	1 hour	24 hours	21 Calendar days
Outage of 3 or more successive lights	1 hour	4 hours	na
Outage of 75% of lights on one tower	1 hour	4 hours	na
Outage of light nearest RR crossing approach, Islands and gores	1 hour	4 hours	na
Outage (single or multiple) found on night outage survey or reported to EMC	na	na	7 Calendar days
Navigation light outage	na	na	24 hours

- Service Response Time -- amount of time from the initial notification to the Contractor until a patrolman physically arrives at the location.
- Service Restoration Time – amount of time from the initial notification to the Contractor until the time the system is fully operational again (In cases of motorist caused damage the undamaged portions of the system are operational.)
- Permanent Repair Time – amount of time from initial notification to the Contractor until the time permanent repairs are made if the Contractor was required to make temporary repairs to meet the service restoration requirement.

Failure to provide this service will result in liquidated damages of \$500 per day per occurrence. In addition, the Department reserves the right to assign any work not completed within this timeframe to the Electrical Maintenance Contractor. All costs associated to repair this uncompleted work shall be the responsibility of the Contractor. Failure to pay these costs to the Electrical Maintenance Contractor within one month after the incident will result in additional liquidated damages of \$500 per month per occurrence. Unpaid bills will be deducted from any monies owed to the Contractor. Repeated failures and/or a gross failure of maintenance shall result in the State's Electrical Maintenance Contractor being

directed to correct all deficiencies and the resulting costs deducted from any monies owed the contractor.

Damage caused by the Contractor's operations shall be repaired at no additional cost to the Contract.

Operation of Lighting

The lighting shall be operational every night, dusk to dawn. Duplicate lighting systems (such as temporary lighting and proposed new lighting) shall not be operated simultaneously. Lighting systems shall not be kept in operation during long daytime periods. If the existing lighting cannot remain operation due to construction activities, then temporary lighting shall be installed. Temporary lighting will not be paid for separately but will be considered incidental to this pay item.

Method of Measurement

The contractor shall demonstrate to the satisfaction of the Engineer that the lighting system is fully operational prior to submitting a pay request. Failure to do so will be grounds for denying the pay request. Months in which the lighting systems are not maintained and not operational will not be paid for. Payment shall not be made retroactively for months in which lighting systems were not operational.

Basis of Payment. Maintenance of lighting systems shall be paid for at the contract unit price per calendar month for MAINTENANCE OF LIGHTING SYSTEM, which shall include all work as described herein.

Electric Utility Service Connection (ComEd)

Effective: January 1, 2012

Description. This item shall consist of payment for work performed by ComEd in providing or modifying electric service as indicated. THIS MAY INVOLVE WORK AT MORE THAN ONE ELECTRIC SERVICE. For summary of the Electrical Service Drop Locations see the schedule contained elsewhere herein.

CONSTRUCTION REQUIREMENTS

General. It shall be the Contractor's responsibility to contact ComEd. The Contractor shall coordinate his work fully with the ComEd both as to the work required and the timing of the installation. No additional compensation will be granted under this or any other item for extra work caused by failure to meet this requirement. Please contact ComEd, New Business Center Call Center, at 866 NEW ELECTRIC (1-866-639-3532) to begin the service connection process. The Call Center Representatives will create a work order for the service connection. The representative will ask the requestor for information specific to the request. The representative will assign the request based upon the location of project.

The Contractor should make particular note of the need for the earliest attention to arrangements with ComEd for service. In the event of delay by ComEd, no extension of time will be considered applicable for

the delay unless the Contractor can produce written evidence of a request for electric service within 30 days of execution.

Method Of Payment. The Contractor will be reimbursed to the exact amount of money as billed by ComEd for its services. Work provided by the Contractor for electric service will be paid separately as described under ELECTRIC SERVICE INSTALLATION. No extra compensation shall be paid to the Contractor for any incidental materials and labor required to fulfill the requirements as shown on the plans and specified herein.

For bidding purposes, this item shall be estimated as \$6,000.00.

Basis Of Payment. This work will be paid for at the contract lump sum price for ELECTRIC UTILITY SERVICE CONNECTION which shall be reimbursement in full for electric utility service charges.

Designers Note: The estimate of cost of service connections for bidding purposes shall be provided by the Designer or Design Consultant.

Electric Service Installation
Effective: January 1, 2012

Description. This item shall consist of all material and labor required to extend, connect or modify the electric services, as indicated or specified, which is over and above the work performed by the utility. Unless otherwise indicated, the cost for the utility work, if any, will be reimbursed to the Contractor separately under ELECTRIC UTILITY SERVICE CONNECTION. This item may apply to the work at more than one service location and each will be paid separately.

For this contract, this pay item shall include all labor, equipment and materials required to install and connect the new system unit duct to the existing 71st Street lighting system in the base of the pole located in the north parkway of 71st Street at the southwest corner of Toyota Park Entrance S2..

Materials. Materials shall be in accordance with the Standard Specifications.

CONSTRUCTION REQUIREMENTS

General. The Contractor shall ascertain the work being provided by the electric utility and shall provide all additional material and work not included by other contract pay items required to complete the electric service work in complete compliance with the requirements of the utility.

No additional compensation will be allowed for work required for the electric service, even though not explicitly shown on the Drawings or specified herein

Method Of Measurement. Electric Service Installation shall be counted, each.

Basis Of Payment. This work will be paid for at the contract unit price each for ELECTRIC SERVICE INSTALLATION which shall be payment in full for the work specified herein.

EXPLORATION TRENCH, SPECIAL

This work shall consist of the exploratory digging at various locations as directed by the engineer for the purpose of identifying the depths or locations of existing underground utilities within the construction limits of the project. For this contract, the words "underground utilities" shall be extended to include water services, storm and sanitary sewers, gas lines, IBT cable and ductworks and other utilities not listed here. Areas shall be backfilled with excavated material in accordance with Section 213, Section 212 and Article 202.03 of the Standard Specifications. Any damages to utilities that occur during exploration trenching shall be repaired or replaced at no cost to the contract. The depth of excavation shall vary as necessary from grade down to 8 feet as directed by the engineer.

All work will be paid for at the contract unit price per foot for EXPLORATION TRENCH, SPECIAL which price shall be full compensation for all equipment, labor and materials need to backfill the trench and the replacement of broken "underground utilities", regardless of the depth that the trench is excavated to. Contractor shall notify J.U.L.I.E. at least 48 hours before start of trenching operation.

LIGHT POLE FOUNDATION, 24" DIAMETER

1. DESCRIPTION:

- 1.1 This term shall consist of the construction of a steel reinforced concrete foundation, 24 inches in diameter, with construction as indicated and complete with raceways, all as indicated on the Contract drawings.
- 1.2 The Engineer shall identify the soil as belonging to one of the types of soil listed in the Foundation Depth Table, either by visual inspection, or by the use of a pocket penetrometer, where this is feasible.
- 1.3 The foundation shall include an excavation, reinforcement, concrete, anchor bolts, nuts, washers and raceways.

2. MATERIALS:

- 2.1 Concrete shall be Class SI complying with Article 504 of the Illinois Department of Transportation (IDOT) Standard Specifications.
- 2.2 Epoxy coated reinforcement bars shall comply with Article 512 of the Standard Specifications.
- 2.3 Unless otherwise indicated, anchor bolts shall comply with the requirements of ASTM Designation A687. Unless otherwise indicated, nuts shall be hexagon nuts in conformance with ASTM A563, Grade A, and washers shall be in conformance with ASTM F436.
- 2.4 The entire length of the anchor bolts as well as the nuts and washers shall be hot dip galvanized in accordance with the requirements of ASTM Designation A153.

2.5 Unless otherwise indicated, conduit raceways shall be heavy wall rigid polyvinylchloride (PVC) conduit, (Schedule 40) UL listed and in conformance with NEMA TC2 and Federal Specification WC-1094A. Raceways shall be of the number and size as indicated.

3. CONSTRUCTION REQUIREMENTS:

3.1 The foundation depths shall be as directed by the Engineer based upon evaluation of the soil conditions encountered. The Engineer may determine soil condition by visual inspection or, where practical, by the use of a pocket penetrometer and will establish foundation depth based upon the Foundation Depth Table shown on the plans, where applicable.

3.2 The hole for the foundation shall be made by drilling with an auger, of the same diameter as the foundation. The foundation shall be cast-in-place and allowed to cure for 10 days minimum before the light pole is erected. If soil conditions require the use of a liner to form the hole, the liner shall be withdrawn as the concrete is deposited. The top of the foundation shall be constructed level so that no shims or other leveling device will be needed to set the light standard plumb on the foundation. A liner or form shall be used to produce a uniform smooth side to the top of foundation. Foundation top shall be chamfered 3/4-inch unless otherwise indicated.

3.3 Extreme care shall be used in establishing the top elevation of concrete foundations, especially when foundations are installed before final grading is complete. Foundations shall not protrude above grade more than the limits indicated on the plans, except for specifically indicated locations, and where not otherwise indicated, foundation shall not protrude above grade more than 4 inches above a 60-inch chord centered at the foundation, at any point around the circumference. Where foundation heights extend beyond specified limits, the Engineer may direct replacement of the foundation and the incorrect foundation will not be measured for payment.

3.4 The steel reinforcement, the raceway conduits and the anchor bolts shall be secured in place to each other and properly positioned in the augered holes so that at time of pouring of concrete mixture in place the above-said components retain their proper positions. Special attention shall be paid to the positioning of the anchor bolts. It is of utmost importance that the anchor bolt projections on top of the foundation, after placement of the concrete, remain in a vertical position.

4. METHOD OF MEASUREMENT:

The foundation shall be measured for payment in linear feet of foundation in place, with the measurement to be taken along the vertical centerline of the foundation except that the total depth shall be not greater than indicated on the Plans and directed by the Engineer, i.e. extra foundation depth, set.

5. BASIS OF PAYMENT:

This work will be paid for at the contract unit price per FOOT for LIGHT POLE FOUNDATION, 24" DIAMETER, which shall be payment in full for the work as shown on the Drawings and described herein.

LUMINAIRE, SODIUM VAPOR, HORIZONTAL MOUNT, 250 WATT

1. DESCRIPTION:

- 1.1 This item shall meet the requirements for the LUMINAIRE, as stated above in these special provisions and in the Standard Specifications for Road and Bridge Construction adopted January 1, 2012.
- 1.2 In addition, the Luminaire shall have a factory applied, black powder coat finish.

2. BASIS OF PAYMENT:

This work will be paid for at the contract unit price per EACH for LUMINAIRE, SODIUM VAPOR, HORIZONTAL MOUNT, 250 WATT, which shall be payment in full for the work as shown on the Drawings and described herein.

LIGHT POLE, ALUMINUM, 35 FT. M.H., 12 FT. DAVIT ARM

1. DESCRIPTION:

- 1.1 This item shall meet the requirements for the LIGHT POLE, ALUMINUM, 35 FT. M.H., 12 FT. DAVIT ARM, as stated in. the Standard Specifications for Road and Bridge Construction adopted January 1, 2012.
- 1.2 In addition, an integral, dual GFCI festoon outlet box with weatherproof cover, and integral flag banner brackets, both as shown of the plan detail sheets, shall be included in this pay item. The pole, festoon outlet box with weatherproof cover and flag banner brackets shall have a factory applied, black powder coat finish.

2. BASIS OF PAYMENT:

The pole, festoon outlet box with weatherproof cover, and flag banner brackets will not be paid for separately, but will be considered incidental to the pay item per EACH for POLE, ALUMINUM, 35 FT. M.H., 12 FT. DAVIT ARM, and will be paid for at the contract unit price per EACH for LUMINAIRE, SODIUM VAPOR, HORIZONTAL MOUNT, 250 WATT, which shall be payment in full for the work as shown on the Drawings and as described herein.

BREAKAWAY DEVICE, TRANSFORMER BASE, 11.5 INCH BOLT CIRCLE

1. DESCRIPTION:

- 1.1 This item shall meet the requirements for BREAKAWAY DEVICE, TRANSFORMER BASE, 11.5 INCH BOLT CIRCLE as stated in the Standard Specifications for Road and Bridge Construction adopted January 1, 2012. The breakaway device for this project shall be a Low Profile Type, as shown on the plan details.

1.2 In addition, the Breakaway Device, Transformer Base shall have a factory applied, black powder coat finish.

2. BASIS OF PAYMENT:

This item will be paid for at the contract unit price per EACH for BREAKAWAY DEVICE, TRANSFORMER BASE, 11.5 INCH BOLT CIRCLE, which shall be payment in full for the work as shown on the Drawings and as described herein.

EXPLORATION TRENCH, SPECIAL

1. DESCRIPTION:

This work shall consist of the exploratory digging at various locations as directed by the engineer for the purpose of identifying the depths or locations of existing underground utilities within the construction limits of the project. For this contract, the words "underground utilities" shall be extended to include water services, storm and sanitary sewers, gas lines, IBT cable and ductworks and other utilities not listed here. Areas shall be backfilled with excavated material in accordance with Section 213, Section 212 and Article 202.03 of the Standard Specifications. Any damages to utilities that occur during exploration trenching shall be repaired or replaced at no cost to the contract.

2. BASIS OF PAYMENT:

All work will be paid for at the contract unit price per FOOT for EXPLORATION TRENCH, SPECIAL which price shall be full compensation for all equipment, labor and materials need to backfill the trench and the replacement of broken "underground utilities", regardless of the depth that the trench is excavated to. Contractor shall notify J.U.L.I.E. at least 48 hours before start of trenching operation.